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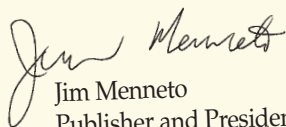
Welcome to the greatest hobby in the world!

Hemmings Motor News is proud to present this special Restoration Guide, with the hope that you will see how easy it is to take the next step in the world of car collecting, and restore a collector car or truck yourself.

It's one thing to own and drive a collector car; it's something else entirely to work on it, and to become intimately familiar with all of its parts and systems. Whether you're simply sprucing up a running, driving car or tackling a full body-off restoration, getting involved with your car's mechanicals, sheetmetal, paintwork and trim is a rewarding experience, one that will provide you with years of enjoyment and a special connection to your car or truck that you cannot get any other way.

Whether your interest is muscle cars, Full Classics, sports cars, trucks or motorcycles, our goal at Hemmings is to provide you with information on as many aspects of the hobby as possible. Part of that involves helping you restore your car—whether you're doing it all yourself, or farming out certain aspects of the restoration to a shop, our editorial staff has assembled a series of primers, tips and tricks to make getting your car in top shape as fun and easy as possible.

This publication would not be possible if it weren't for the generous support of our sponsors and the more than 175 advertisers you will find in this book. With help from these suppliers, you will soon be able to restore whatever collector car or truck you've always dreamed of owning. Roll up your sleeves and get ready to get started in the rewarding hobby of automotive restoration!



Jim Menneto  
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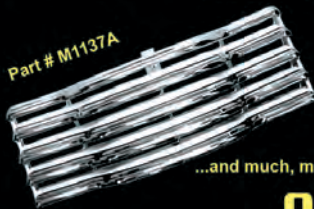
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# GETTING STARTED

## How to get started in the rewarding hobby of collector-car restoration

BY CRAIG FITZGERALD AND RICHARD LENTINELLO



**T**here is nothing more fulfilling than restoring an old car and making that dream of collector-car ownership come true. When the day comes and you're able to drive proudly down the street in a car that you yourself built, it will make you feel like you're on cloud nine. Few other things in life can do more for your self-esteem than showing off an old car or truck that you restored with your own two hands.

If you've never restored an old car before, here are a few tips to help you through taking on your first restoration project. With the right amount of planning and a positive attitude, even if your finances are limited, you will still be able to do it. Thousands of other old-car enthusiasts have done so with positive results, so there's no reason why you, too, can't complete your own restoration successfully.

### BUYING YOUR FIRST PROJECT CAR

Always buy the best possible car you can. Avoid basket cases, because there will inevitably be parts missing; steer clear of heavily rusted vehicles, because it will cost you more to repair the body than it would to simply buy a more expensive car with little or no rust in the first place. No matter what your dream car is, don't fall for a seriously rusted car with missing parts as your first project: Wait to tackle a difficult case until you get some experience

under your belt.

When it comes to deciding which car or truck you're going to buy, keep in mind that some makes and models are easier to restore than others. If you like muscle cars, you might consider a restoration of a 1964-'70 Mustang, 1968-'69 Camaro or a pre-1973 Chevelle or GTO, as opposed to a Buick GS from the same era. The Buick is a lot rarer, so there isn't the same amount of support from the aftermarket in terms of reproduction parts compared to more popular cars, which have had nearly every body, trim and interior part reproduced, and at an affordable price, too. We're not saying to avoid restoring a GS or an Olds 4-4-2, mind you. Quite the contrary. But in terms of availability, parts for the Chevelle are much easier and cheaper to come by, making the project much more straightforward and affordable for the first-time restorer.

If you prefer Italian sports cars, cars like early Alfa Romeo Duettos or 1750 Spiders might be a wiser choice for a first-time restorer than something more expensive and complicated like a Ferrari. The cost of restoration, the know-how required, the simple fact that the Alfa has four cylinders to the Ferrari's eight or 12—it all means that restoring such a car will be simpler than restoring the Ferrari.

### COST, CONDITION AND COMPLETENESS

Once you settle on the kind of car you're interested in, give a lot of consideration to the condition of the car you're going to buy. Condition and completeness will largely dictate the time and expense required to complete the restoration. The portions of your restoration that encompass the car's mechanical systems (engine, drivetrain, suspension, electrical, braking, interior, etc.) will be much simpler to finish if the car you're interested in restoring has all its parts in place from the get-go. Spending less money on a car that has half its parts missing, or has parts that are crammed in mislabeled cardboard boxes, is a false economy—you'll most likely spend at least as much as you "saved" (and way more in time and effort) tracking down the correct parts.

In terms of the body and interior, a car that has a complete, mainly rust-free exterior, and mostly unmolested interior is much more desirable as a restoration project than something with perfo-



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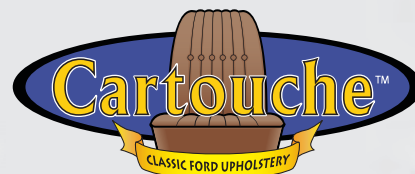
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rated floors and a destroyed dashboard. Therefore, it's always better to buy a rust-free car from the dry Southwest and ship it to where you are; the cost of shipping is a whole lot less than rebuilding a rusted shell. Plus, cars that retain their original body panels are always worth more due to their higher level of originality and superior structural integrity. And even if the interior on the car from the Southwest is all dried and cracked, it's easier to replace the upholstery and carpeting than it is to pay to have new floorpans and quarter panels welded on.

### INSPECTIONS AND SHIPPING

It might be simpler to buy that BMW 2002 or Chevy C10 you saw on your way home from work, but in the long run, you may be well served by buying a better vehicle that's 3,000 miles away. The trouble is, how do you know what you're buying, and how can you get it home?

Most professional appraisal services also offer pre-purchase inspections as a service. For a

very reasonable fee (plus travel costs if the subject car is far from the appraiser's location), an appraiser can provide you with a pre-purchase inspection like that you might have had when you purchased your home. Such an inspection not only gives you peace of mind, but it can act as a bargaining tool with the seller should the appraiser find certain aspects of the car that are seriously wrong. They will provide you with a complete list of the things that the car needs, so you can begin budgeting for your restoration, as well as planning for the work you'll need to get done. The best appraisers can visit a car, take digital photos, prepare a report and have it to you within 24 hours.

Once you decide that the car is right for you, getting it home can be a concern, especially if it's halfway across the country. Dozens of companies offer transportation services that take the worry out of transporting cars long distances. Depending on how far the car has to go, shipping with one of the professional carriers is affordable—and it's worthwhile if you manage to buy a better car that isn't going to require the time and effort of a more local car that might have rusted floors and missing parts.

### INSURANCE AND REGISTRATION

From the moment you purchase your car, insuring it against fire, theft and crash damage is critical, even if you don't plan to register it immediately. One of the many collector car-specific insurance companies is the best choice for having your car insured, especially during the restoration. The fees for insuring a collector car are nominal, and the underwriters who insure your car will be able to work with you to determine an agreed value based on its current condition, which may be quite low before you start restoring it, or quite high when its restoration is completed. You can regularly update your policy to reflect the work done to the car,



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## GETTING STARTED

thereby protecting yourself in the event of a catastrophe. Insurers will also provide coverage during shipping.

Registration and titling can be a surprising thicket of bureaucratic nonsense. Before you agree to purchase your car, take the time to get in touch with your state's Department of Motor Vehicles to determine what you'll need to register your car when it's roadworthy. Many restorers have gone through a lengthy restoration process, only to learn that their state requires a title to register a vintage car, that they owe years of back title fees with penalties calculated based on the date that they purchased their car, or that the sales tax due is now based on the car's restored value, versus that of the project car that they bought for \$1,000. A few minutes on the phone with the DMV can result in thousands of dollars saved when it comes time to register the car.

### TOOLS AND SPACE

We have chapters in this guide that will offer more specific information on tools and workspaces, but suffice it to say that you're going to need both. How much of each will mostly be up to you, and how willing you are to work within the limits of your toolbox and your environment. At the minimum,

you'll need a good set of SAE and/or metric hand tools, and access to electricity for power tools such as a sander or compressor.

### DOCUMENTATION

Take lots of photographs of the car from every angle, inside and out, with numerous detail shots taken close up so you will know later on just how everything originally was assembled and connected.

### BEFORE YOU GET STARTED

If the engine doesn't run at first, get it started so you can hear the engine and detect if there are any serious internal noises, leaks or smoke being emitted. Then try to drive it, even for a short distance, because you want to know if the transmission shifts properly and if the differential is okay. The state of the brakes and suspension are non-issues, because you are going to rebuild those systems anyway—but check to see if the instruments, lights, heater and A/C work, and that the windows crank and doors lock. This will allow you to know which parts have to be replaced, and give you the advantage of ordering those parts ahead of time so you won't have to waste time waiting for them to arrive, delaying their installation.

### TOP TIPS

- Buy a car that's within the limits of your pocketbook.
- Buy the most complete, rust-free car you can find.
- Don't be afraid to buy a car thousands of miles from home, if it offers advantages over a local car.
- Insure your car with a collector-car insurer from the moment you purchase it.
- Check with your DMV to determine registration and titling requirements ahead of time.
- Decide what type of restoration to do before starting.
- Document everything by taking lots of photographs of every detail.

*Continued on page 93*



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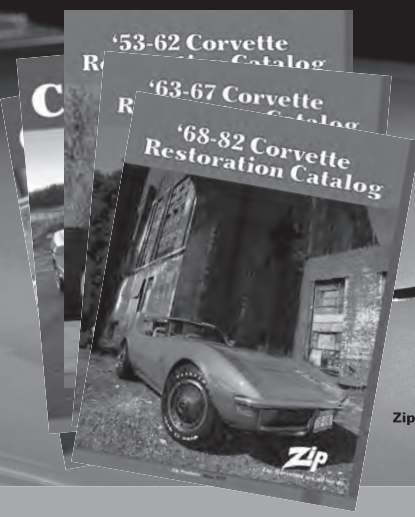




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# SETTING UP A WORKSPACE

Create an organized shop to make restoration a pleasure

BY RICHARD A. LENTINELLO

**S**etting up a garage for your old-car restoration needs is the single most important phase of your car's restoration: Without a properly equipped shop, you will not be able to rebuild your old car, truck or motorcycle in a timely, correct or safe manner.

Despite having limited space and lacking certain specialized tools necessary for some

projects, many DIY restorers are able to complete amazing restorations, thanks to talent and ingenuity. But having a well-equipped garage makes restoring old cars a far more enjoyable experience. Thinking about your workspace ahead of time, and setting it up for the work at hand, will make your restoration go that much easier and quicker. ●

## ELECTRICITY

*The most important thing your workspace needs is power. If your garage is not already wired, run as much amperage as possible. Using a licensed electrician, install an electric panel with dedicated circuits controlled by their own circuit breakers. Plan ahead for your electrical needs. Even if you don't have a compressor or*

*a gas heater now, you might in the future, so have a dedicated circuit installed and at the ready when you wire your shop.*

*You can never have too many outlets. Install as many GFCI (ground fault circuit interrupters) as possible at workstations and near garage doors to cut down on the use of extension cords.*

## LIGHTING

*To see the work at hand without straining, you need to have a brightly lit workshop. At the workbench, install either a four- or six-foot fluorescent fixture overhead; they are fairly inexpensive*

*and easy to install. If you live in a cold climate, be sure that all of your fluorescent fixtures have electronic ballasts, rather than the standard magnetic ballasts—they work better in cold weather.*

## SAFETY

*Shop safety is critical. Restoring a car requires some activities that may be dangerous, so protect yourself with as much safety equipment as possible.*

*Protect yourself, your home and your car with a range of fire-suppression equipment. A fireproof cabinet for combustibles is a must. Keep all oily and dirty rags in a metal fireproof container for storage, and place all dirty disposable shop towels*

*in a container outside the garage. Most importantly, a 10-pound fire extinguisher is a must. Two—one at each end of the garage—would offer even better protection.*

*Don't forget to protect yourself, as well. Safety goggles and safety glasses, several pairs of work gloves, dust masks, and an OSHA-approved dual-cartridge mask for painting are essential. Don't skimp on protective gear.*



## SPACE AND STORAGE

*It's certainly possible to restore a full-size American car in a one-car garage, but you'll be spending a lot of time working on it outside due to space limitations. Some enthusiasts have even rented garage space in order to complete tasks like removing the body from the chassis. Maximize your space by organizing your shop. Garden tools and bicycles should be stored elsewhere, like in a basement, in order to free up garage space.*

*Many hardware stores sell garage-specific cabinets, but if you're cost-conscious, you can use old kitchen cabinets, or go to a used furniture store and buy some old metal cabinets. And old kitchen countertops make ideal workbenches.*

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## SETTING UP A WORKSPACE



### LIFTS, JACKS, STANDS AND DOLLIES

You'll need a variety of jacks during the course of the restoration. At the bare minimum, you'll need a rolling floor jack that's rated to a capacity well over that of the weight of your car. Avoid buying cheap jacks due to their inferior quality; spend a few extra dollars and buy a good-quality, heavy-duty hydraulic jack like those used in a professional garage. Jackstands are mandatory for safety—never use a jack alone to support a car.

If you have the space and the money, consider buying a four-post lift. Many suppliers offer lifts that are a reasonable investment, providing convenience and safety that can't be matched by a simple jack. Considerations include the weight of your car, and the space you have available, as most require a minimum ceiling height of about 10 feet.

Many manufacturers offer jack-equipped wheel dollies that making rolling a car around in the garage a snap.

For a full body-off restoration, there's nothing better than a rotisserie that allows you to rotate the body 360 degrees. Spinning the body around will give you unobstructed access to the undercarriage, making the work easier, quicker and superior in quality.



### TOP TIPS

- Consider your future electrical needs.
- Always store dirty rags in a fireproof trash can.
- Always store paints and chemicals in a fireproof storage cabinet.
- Use quality heavy-duty jacks and jackstands.
- Storage cabinets need to be durable.
- Maximize the use of proper lighting.



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## CHAPTER 3

# TOOLS

### What you'll need to get the job done right

BY DAVID TRAVER ADOLPHUS

**P**lanning only takes you so far in a restoration. All the research and groundwork in the world won't help you when it comes time to drop the transmission...only to find it requires an  $1\frac{1}{2}$  Allen wrench for an obscure fitting, the hardware store doesn't open until Monday morning and now you're all dressed up with no one to take to the dance. There's a reason so many of us in the hobby acquire tools compulsively—we just know we'll need them, someday.

A restoration will be that day. Nothing taxes your toolbox more severely than the innumerable unexpected challenges of restoration. That's when you go from feeling like there isn't a situation in the world you can't tackle, to wondering what you got yourself into. It happens to everyone, but budgeting time and money up front to make sure

you're equipped for the task at hand will mean more time to spend on the real, fun work later.

A complete set of basic hand tools and a collection of useful power tools like an impact wrench, angle or die and bench grinder and drills are the minimum you'll need. Almost all projects will benefit from pneumatic metal shears and a die grinder, a media-blasting rig and a welding setup. Then there are the jack stands, hoists and lifts, painting tools, safety equipment, metalworking tools—you could, and many of us do, spend all your time hunting down tools and never get around to the actual work. Much better, then, to establish a baseline set, then think about your future needs and desires, and decide just how far you want to take your obsession. ●

#### TOP TIPS

- Don't forget to support large parts properly—never rely solely on hydraulics, and always employ jack stands or other solid support for safety.
- Rechargeable LED lights are now available, and while they're not nearly as bright, they don't get hot and are handy for occasional detail work.
- You may be able to trade time spent sanding or performing other simple tasks for instruction.
- Get in the habit of using a rotary tool to etch your name on every tool you acquire, as soon as you get it.
- Look for complete kits that let you hit the ground running.
- A cloth liner impregnated with penetrating oil will help prevent rusted tools.



*You'll never regret having multiple ways to move multiple car parts. Engine hoists, transmission jacks and stands, rolling car jacks and dollies all make it a pleasure to access your car, and access is one of the keys to a quality restoration. Large items like engine hoists can be rented or borrowed, but you'll find dollies useful time and again.*

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# TOOLS



*The fundamental tool of sheet metalworking is the English wheel. With half a dozen or so anvils, you can shape, stretch, shrink and otherwise make sheetmetal dance. Basic English wheel techniques can be learned in a weekend with a good instructor—perhaps along with hammer and dolly work and welding. The wheel itself is a major investment, but will pay for itself with the first pair of fenders created from sheetmetal.*



*Good lighting is one of the best investments you can make. Make sure you have a variety of inexpensive quartz lamps, including some large stand lamps and several smaller 250-watt portable units. They allow you to get a good look at what you're doing, which makes for better work. They do get hot, though.*



*A set of basic, quality bodyworking tools—dollies like these curved, general-purpose, heel and double-end hand dollies, a spoon, and pick and bumping hammers—are not terribly expensive and will last for decades. A good metalworking book and a weekend class with an experienced shaper—or just some time in the evenings spent with a local restorer—will have you off and running in no time.*



*Basic hand tools don't need to be fancy, but they do need to be high quality if you want to avoid the curse of rounded-off bolts and other nightmares. A used-tool store will help you fill in gaps, and you'll want to fill those gaps whenever you can, rather than on searching desperately on a Saturday night when you need to twist a certain bolt. You should have sets of combination wrenches, sockets and Allen wrenches in SAE and metric sizes, as well as other handy hand tools.*



*If you haven't welded before, or haven't tried since using a torch in shop class, a MIG welder is a revelation. You may also be amazed by how affordable it is to get started, with quality welders available for under \$200 that can weld ¼-inch metals, and heavier duty ⅜-inch models in the \$350 range, still operating on household current. More than one person has picked up a MIG welder for the first time, watched a few videos, and gone on to perform all the welding on their own car immediately thereafter.*



*Thousand-dollar tool vaults are pretty, but aside from very heavy items, they don't hold tools any better than a yard-sale cabinet. If you keep tools organized in a way that makes sense to you and label them for easy access, a restoration will be much more fun, as you avoid the headache of looking for that one tool you know you have. It even saves money in buying duplicate tools.*

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# MUSCLE CAR RESTORATION

High-performance specimens can be highly rewarding projects

BY MARK J. McCOURT

**T**he American automotive industry has gone through a number of distinct phases in its first century of existence. It can be argued that none has been more colorful and exciting than the muscle car era, spanning the mid-1960s through the early 1970s—a time when the burgeoning youth market, cheap gas and an emphasis on power that reached the moon and beyond pushed automakers to build cars and light trucks with stunning new levels of turnkey performance. Today, muscle cars remain enduringly thrilling and more than a little dangerous, making them favorite candidates for owning, driving and restoring. After all, there's no better way to recapture the exhilaration of youth than from behind the wheel of every teen's dream car.

Restoring muscle cars of all types—intermediates, full-sized muscle and big-cube pony cars—has evolved from a satisfying hobby into a high-dollar business in the past decade, but this sea change doesn't mean that a restoration project on your favorite General Motors, Ford, Mopar or independent muscle machine is now out of reach. In fact, the enduring popularity of American muscle cars has fostered a healthy aftermarket industry that can provide restorers of every stripe with everything from carpet kits and redline tires to crate engines and entirely new bodies. And the fact that these cars remain defiantly analog in today's digital world means that they are relatively straightforward to restore. In fact, some of the finest Chargers, Chevelles and Cobra Jets on the road today were rebuilt in their owners' home garages, using a basic array of standard tools.

So whether you enjoy getting your hands dirty or you'd rather leave it to the professionals, you'll find that the muscle car fraternity is a huge and rewarding one. The time to rehabilitate that blast from the past, never-to-be-duplicated slice of powerful Americana is now. We may grow older, but restored muscle cars remain forever young, and they help us to feel that way, one smoky burnout at a time. ●



*A muscle car like this 1968 Oldsmobile Cutlass Ram Rod 350 may not feature today's complex technologies, but it remains a machine made up of many parts. It is crucial to carefully inventory, mark and store every component that you remove from your vehicle, down to the smallest bolt and fastener. Taking care of these details at this stage will ensure that your component refinishing and final assembly will go smoothly.*



*One of the benefits of the body-on-frame construction of most muscle cars—and in this 1969 Chevrolet El Camino SS 396's case, muscle trucks—is the opportunity to assemble the suspension, engine, driveline and braking system with ease, and to ensure that these components are finished to your desired standard before the prepared body is reintroduced. The ability to roll the frame in and out of your work area also eases space restrictions.*



*Having access to a movable rotisserie stand makes restoring a unit-body muscle car like this 1968 Shelby G.T. 500 KR convertible a much easier and more pleasant task. Having the ability to roll the body into various work areas without disturbing it is a plus, while being able to turn it to any angle—top, side or bottom—to effect metal repairs, surface preparation or painting, makes it much easier on the restorer's own body.*

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# MUSCLE CAR RESTORATION



*It may surprise some that muscle cars like Pontiac's GTO debuted advanced technologies, here in the form of the famous color-matched, impact-absorbing Endura front bumper. The Endura nose of this 1970 GTO Judge Ram Air IV was easy to restore to factory perfection with today's modern urethane fillers, primers and flexible paints, and that ease applies to other cars with soft bumpers, including 1970s Corvettes, Camaros and Mustangs.*



*Racing stripes were a hallmark of the muscle car era, and Ford, Mopar, AMC and GM's various divisions applied 3M-sourced adhesive decals, painted the stripes directly on the car or, in some cases, did both. This 1971 Hornet SC/360 featured decal stripes, and they, like virtually every muscle car stripe used, can today be purchased as high-quality reproductions. Stencils are also available to help restorers reproduce factory-painted stripes.*



*One of the decisions that a restorer has to make when tackling a project like this 1966 Mercury Comet Cyclone GT is how extensive the vehicle restoration will be. Cars that are in otherwise good condition may only require fresh exterior paint and trim. More worn examples may benefit from disassembling the suspension and removing the engine and gearbox to repaint those components and the surrounding bodywork.*



*Media blasting and grinding are common methods of paint removal, but in the restoration of this 1970 Plymouth Superbird, the restorer chose to apply chemical (also called aircraft) stripper by hand to each body panel. The benefit of this choice was that the old paint was removed, but the factory-applied, electrostatically charged rust inhibitor, seam sealer and sound deadening underneath remained intact.*



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# MUSCLE CAR RESTORATION



Sanding is a crucial part of the surface and paint preparation during a quality restoration, and seasoned restorers keep a wide variety of grades of wet and dry sandpaper on hand. This 1974 AMC AMX was block-sanded with increasing grades of sandpaper after its primer coat and filler application, as well as after its colored guide coat and between each of its four coats of single-stage polyurethane paint.



Most home restorers keep a pile of old blankets handy to use in protecting newly restored components from damage. This is a smart idea, and true professionals take protection even further, masking alternating components with cloth, cardboard or thick paper as they work inside and out to ensure that their finished muscle car has received a true show-grade restoration, like the one performed on this 1971 Ford Torino GT convertible.



Vinyl roof covers were a popular trend in the 1960s and 1970s, and muscle cars like this “White Hat Special” 1967 Dodge Charger were not immune to receiving the faux convertible treatment. Because these covers can trap moisture against the sheetmetal and encourage hidden rust, it’s important to properly treat the roof—priming, sealing and painting it—before the top is glued down and its trim is installed.

## TOP TIPS

- Like all vehicles, many muscle cars have been canvases for personal expression. Factory-correct restorations using NOS and officially licensed parts have been bringing big dollars in recent years, but this shouldn’t dissuade you from picking up a car whose engine or transmission has been replaced. You can make a car as personal, or as factory stock, as you desire.
- Be aware of the “cloning” phenomenon, in which unscrupulous people modify lesser muscle cars to appear to be valuable ones. It’s smart to check with your car’s enthusiast club to find resources to help authenticate your car’s particular powertrain and optional equipment.

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# CLASSIC CAR RESTORATION

## Variety and challenges abound when restoring American cars

BY JIM DONNELLY AND RICHARD A. LENTINELLO

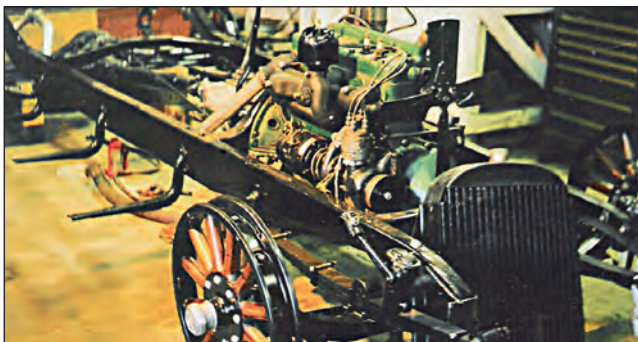
**W**hen it comes to restoring classic cars, there are many different types of vehicles that fall into different categories depending on their year of manufacture. Full Classics, as named by the Classic Car Club of America, are cars like Auburns, Duesenbergs, Pierce-Arrows, Cords, Stutzes and certain Cadillacs, Nash, Packards, Studebakers, Bentleys and Rolls-Royces. Cars that are referred to as classics, with a lower-case “c,” can be almost anything, but usually are pre-1980 vehicles.

Cars tend to get more complex, and more highly accessorized, as they get more recent. Restore a car from the 1950s and you’ll be educating yourself about great arrows of chrome, brilliant colors, wild upholstery schemes and carpets fused with chromed fibers. On the plus side, you’ll be dealing with overhead-valve V-8 engines and automatic transmissions, easy-to-rebuild suspensions and brakes and fairly thick body panels that are a cinch to repair and weld. Another plus is that nearly all mechanical and electrical parts, not to mention a fast-growing selection of

body and trim parts, are readily available and affordably priced for cars of the post-war era, which includes up until the early to mid-1970s.

When it comes to restoring real Classics—or most cars and trucks built prior to World War II, especially those manufactured during the 1920s and ’30s—you will have to deal with a host of different issues, such as wooden inner frames that support the outer body panels, wood floorpans, lots of cast metal parts, flathead engines, mechanical brakes, updraft carburetors and wire or wooden wheels. And depending on the year of the vehicle’s manufacture, instead of having parts plated with chrome, they will have to be nickel-plated. Different upholstery fabrics come into play as well, including broadcloths and mohairs, and you’ll even have to work with linoleum-type material for roofs and running boards.

What you’ve got to remember is that regardless of era, American classics represent the finest the world of cars can offer. Countless fans have gotten them rolling again using no more than basic garage tools. You can do it, too: just try. ●



*It’s never shake-the-crate simple, but this 1927 Dodge undergoing restoration demonstrates that older cars can be pretty basic: two frame rails, a few crossmembers, and the engine installed. The flip side is, parts can be very dear, such as this car’s Dodge-specific 16-valve cylinder head by the racing specialist, Roof. Restoring wooden wheels generally requires a specialist, too.*



*You can’t go wrong by restoring an early two-seat Ford Thunderbirds. The owner of this 1957 Thunderbird has had it since 1961; he wanted a concours-level restoration, but thousands of other Early ’Birds have benefitted from garage resurrections. This is one of the most popular and iconic post-war American cars. Whole suppliers focus on nothing but Thunderbird parts and accessories.*

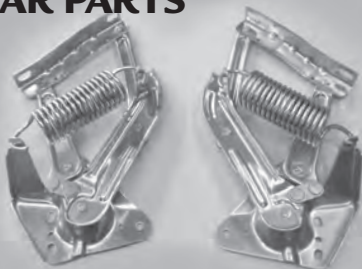
### TOP TIPS

- Don’t rule out early cars; mechanically simple pre-war classics can make rewarding initial projects.
- Classic cars have their own character; learning to refinish a wood body or repair wire wheels can be a grand adventure.

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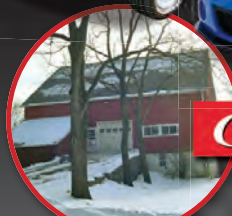
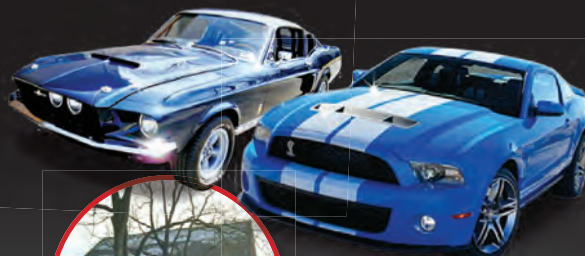
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# CLASSIC CAR RESTORATION



*This 1967 Buick Electra 225 was rear-ended hard while on a classic tour. These huge luxury convertibles are tough cars, though. The owners replaced the bent rear bumper, valance panel and trunklid and did a full repaint; when finished, the Buick was better than it was before the accident. Electra 225s from this era are still remarkably cheap to buy and redo, and some can still be found on used-car lots.*



*Classics such as this Mercer feature solid front axles, mechanical brakes and many handmade brass and cast metal parts. Finding replacement body and trim parts is near impossible, so in order to restore one, you will need to be well versed in the art of metal fabrication. Knowing how to use an English wheel, metal lathe and milling machine to produce the parts that are missing, damaged or fatigued due to their nearly century-old status will be helpful.*



*Believe it or not, this in-progress restoration of a stunning 1947 Chrysler Town & Country sedan, was carried out by a bunch of novices from rural Vermont, including the owner. It took three years and some 5,000 hours, but this car, with handmade wooden bodywork, is now concours-worthy. Most people restoring wood-bodied classics, which are enormously valuable, tend to hire pros.*



*There's a worthy lesson in this photo. This is a landmark post-war car, a 1949 Cadillac Club Coupe. The owner had limited space in his garage, so he couldn't take the usual step of removing the body from the chassis. Regardless, he hand-stripped the frame and body with wire brushes, and applied a show-quality finish without a paint booth, using plastic sheets and a house fan to keep the dust off the fresh paint.*



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# HOW TO CHOOSE A SHOP

If you can't do it all yourself,  
here's how to find help

BY RICHARD A. LENTINELLO



**B**efore engaging in a restoration, there are a few decisions you'll have to make. Do you want a 100-point concours-perfect automobile or a really nice street restoration? Do you plan to use as many NOS parts as possible, or are reproductions okay? Most importantly, are you going to do all the work yourself, will you send some tasks out for someone else to perform, or will you hire an outside restoration shop for most of the project?

This guide is intended for home hobbyists who are getting started in the restoration world; you'll be doing most of the work yourself, and you're eager to get started. However, even the most experienced restorer sometimes runs up against a task that they're not comfortable performing with their current skills and equipment. In that case, you'll want to find a professional to help.

To ascertain which restoration facilities offer the best service and quality for your needs, you should visit several different shops during working hours. This will give you a good idea of how a restoration shop operates, and indicate the skill level of its workforce.

Rule number one when looking for a restorer: Never, ever, go to a local garage or body shop, even if they advertise a restoration service. They simply do not have the skills or knowledge necessary for such a job. They only know tune-ups and collision work. They haven't the faintest idea about the intricacies of a true classic-car restoration—especially if they try to assure you that there is nothing magical about it. Always keep in mind that restoration firms are not body shops and body shops are not restoration firms. They are two distinctly different types of business.

Like any business that relies solely on a

skilled workforce to produce a finished product (as opposed to a manufacturer or retailer), a restoration business is very difficult to run due to the extensive use of hand labor, which always limits the cash flow. By understanding the numerous problems that a shop proprietor has to deal with, you will be able to comprehend why he has to perform certain tasks, charge for each of those tasks accordingly and expect you to make payments promptly.

To get the best job for your money, it is important to deal with a shop that specializes in your car's particular make and/or model. No one knows everything there is to know about a particular vehicle and its parts, but specialists come close—and know other specialists who can help, making sure any problems inherent in the restoration of your particular car can be successfully solved in a timely manner.

If the shop you choose has never worked on your type of vehicle before, your car or truck may be the experimental vehicle they wind up learning on—a potentially costly turn of events. Dealing with non-specialists will result in higher restoration costs, because they take longer to do things due to their unfamiliarity with the car. When you are being charged by the hour, every minute counts. Also, the end result will likely not be of the same quality, nor will the car be restored to the correct specifications.

When you think you have found the proper facility to restore your car, don't be afraid to ask the shop owner questions about his experience and the techniques he uses. Ask him about his background and how long he has been in the restoration business. Ask about his employees and their individual experience in the field. Take the time to inspect the workshop, and take a detailed look at the work being performed on the cars currently under restoration.

The ideal restoration facility will have all the necessary tools and equipment needed to carry out its work in the most efficient manner with the best results, including a spray booth for higher-quality paintwork. It is also important for you to inspect a couple of vehicles that the restorer has completed, and ask for at least three references from former customers.

Because no two cars are alike and no two cars are in the same condition when their restorations begin, it would be unjust for you to compare

your cost estimate with that of another vehicle. It is also very difficult for the shop owner to provide an estimate that will hold true throughout the length of the restoration process. Because the restorer doesn't have X-ray eyesight, he simply cannot judge the amount of rust and body repair that might be required without disassembling the entire vehicle and inspecting every component. And because he cannot foresee every single problem, most restorers have a clause in their contracts that states an additional charge will be incurred if extra work is required.

Specialized restorers who have extensive experience with a particular model already know exactly how many hours of labor it will take them to strip and paint that vehicle, restore its frame and rebuild the suspension. This allows them to charge a flat rate for each job, because the work really doesn't vary much from car to car. However, if extra repair work to the body or frame is necessary due to a car's below-average condition, then you will be charged for the additional work.

Most of the better-quality restoration shops

specializing in highly collectible cars bill their clients on a time-plus-material basis due to their ability to pay for a true, perfect, 100-point restoration. Hourly billing is the most expensive way to pay for a restoration, but if you want the absolute highest quality possible, there is no alternative—particularly from the restorer's perspective, since he will have to put in endless hours of labor until every single aspect of the car is perfect.

Be very skeptical of the shop that says it will restore your vehicle for a price that seems too good to be true. Once they have your car apart, if the work is much more extensive than they anticipated (and it usually is), you can be sure they will cut corners in places you won't notice immediately. This can lead to a dangerous situation if they decide not to replace fatigued brake lines or a weak suspension support bracket.

After both parties have agreed to terms, you must provide a deposit so the restorer can begin working. This lets the shop start ordering the parts and supplies they need to get started. The better-run shops will invoice you on either a weekly,

*Continued on page 94*



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# IMPORT CAR RESTORATION

## Getting your favorite foreign car ready for the road

BY MARK J. McCOURT

**A**n amazing number of automobiles built in countries outside of the U.S. have been imported here in the past 110 years. Americans seeking something a bit outside the ordinary have been able to purchase cars built in countries as close as Canada and Mexico, and from as far away as Australia and Japan. From British sports cars to German luxury cars to French economy cars, all of these imports have offered American drivers a different set of values, a special flavor and a unique perspective on the motoring experience.

It's true that some of the more esoteric imports can be a challenge to restore due to a lack of aftermarket support and a scarce parts supply. In those cases, some of the excitement of undertaking a restoration may come from dealing with overseas suppliers, or perhaps even traveling to a foreign country to buy parts in person. And on the other hand, the enduring popularity of other imports—England's MGs and Triumphs, for example—has enticed parts suppliers to tool up everything from

fenders to the bolts that hold on the license plate, making these cars as easy to restore as turning the page of a catalog, much like an early Ford Mustang or a Tri-Five Chevy Bel Air.

And some automakers, like Germany's Mercedes-Benz and England's Aston Martin, even offer in-house heritage restoration services. No matter the difficulty or ease of sourcing restoration parts, the techniques that will be used to repair or replace sheetmetal, to upholster seats or to install exterior trim are virtually the same for any automobile, whether imported or domestic.

The boundless enthusiasm that imports engender also means that you will often find marque-specific clubs filled with like-minded people, as well as dedicated specialists who maintain and restore these enticing cars. So whether you choose to tackle a restoration in the comfort of your own garage, or to work with a professional specialist, you can expect to enjoy the fruits of your labor in owning and driving a vehicle that is as unique as you are. ●

### TOP TIP

- Establishing the available support for your chosen imported car is a good way to start. Visit

[www.hemmings.com/hobbydirectory](http://www.hemmings.com/hobbydirectory) for an overview of the resources and clubs linked to your car.



*British sports cars, like this 1959 Austin-Healey Sprite, tend to be among the easiest and least expensive imports to restore because they enjoy a strong enthusiast following, numerous specialists and a ready parts supply. Some older Brits differ from their European or American counterparts by their use of Whitworth hardware, which means that you can't pop down to the local hardware store for a box of fasteners.*



*Like its Mercedes-Benz and Porsche counterparts, BMW still produces and stocks a surprising number of mechanical, body and trim components for classic models like this European-market 1972 Touring 2000 tii. The fact that you can order factory-approved, original equipment parts through a specialist or even over your local dealer's parts counter is a boon to completing factory-correct restorations like this one.*

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Although the sporty Datsun 240Z was ubiquitous in the early 1970s, age and attrition have taken their toll on the car's population today. The differing quality of steel and rust-proofing methods mean that those examples remaining will likely be riddled with some rust. Japanese cars tend to be more challenging to restore because they don't share the Europeans' accepted collectibility, so sourcing parts and sheetmetal can be more labor-intensive.



On the whole, European and Japanese automakers made the switch from body-on-frame to unit-body construction earlier than American automakers did. This means that unit-body cars like this 1963 Jaguar E-Type roadster have complex structures that may easily hide rust and crash damage. Depending on your budget and your intentions for the car post-restoration, you may take a car down to its elements to properly treat all metal.



One of the benefits of owning a popular sports car like the MGA 1600 is that its supporting aftermarket offers a great many options when it comes to choosing how to restore it. Numerous parts companies offer factory-correct restoration parts that range from hose clamps to wiring looms to chrome grilles. Personalizing a car with a new color, upholstery or steering wheel during the restoration process is a valid choice.



Many specialist restoration shops and capable owner-restorers have created dollies to help them transport bare body shells, like the one supporting this 1974 Porsche 911 Carrera. Even handier are the rotisseries that can be bought or scratch-built to allow a restorer easy access to every part of a car, eliminating the need to lie on your back or work at uncomfortable angles. In addition to easing metal repair, these tools are helpful when painting.



Reassembly can be the most fun part of a restoration, as that's often when a car begins to take on new life, as in the case of this 1972 Volvo 1800ES. While the temptation may be great to hurry through reassembly and to get your car back on the road, taking your time during this step will determine the outcome; it's easy to dent, scratch or otherwise damage a newly painted body, fresh engine bay or upholstered interior if you don't protect your previous work.



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# VINTAGE TRUCK RESTORATION

Rugged utility meets classic appeal to create growing popularity

BY DAVID TRAVER ADOLPHUS

PHOTOS COURTESY BOB SEKELSKY, HEROBX

**W**ith a few exceptions, both acquiring a collectible truck and restoring it will be simpler and cheaper than the same work on a comparable car. Vintage trucks were seldom equipped with the complex seeking radios, Lucite trim or even air conditioners of classic cars. In most cases, there's simply less to restore, period: Interiors were often painted metal, as opposed to upholstery; dashes were a dead simple collection of gauges in a basic surround; and you almost never have to worry about sourcing obscure carpet materials, because you're lucky if there were rubber mats. There are fewer windows, no back seats, certainly no electric controls and generally less trim. In addition, trucks are almost universally body on frame and are easy to disassemble and access. If you're working without a lift, a chassis naturally located higher off the ground makes many tasks much more comfortable.

You won't find many exotic, high-compression dual-quad engines underhood, either. For most

years, straight-six power was specified—truck buyers wanted durability and off-the-line torque, not any high-speed antics. Couple that to low gearing, and it becomes worth thinking about how you plan to use your truck. Most trucks produced before the mid-Fifties won't be capable of highway speeds without modification, and they won't be the sort of thing you'll want to take down wet, twisty roads. Even on the fancy, high-spec models, there's a vehicle made for work underneath.

There's a difference between "simple" and "easy," however. The tradeoff—and it can be a big one—is the lack of reproduction parts for anything but the most popular, and therefore most expensive, models. The bodywork and mechanical components may be simple, but you'll be doing a lot more work on them, rather than ordering fresh from a catalog. There's good support for many post-war Ford and Chevrolet trucks, and certain "cult" vehicles such as the Dodge Power Wagon, but that still doesn't mean you'll be able to go out and



*Trucks had harder working lives than most cars, and extreme measures were often employed to keep them running. That can mean not just normal age-related issues, but dealing with the efforts of previous repairs. Here, the original wood bed on a 1959 Ford F100 emerges, having been hidden by a metal bed placed on top. Changes to the bed are very common.*



*Media blasting, sandblasting or dipping will reveal the extent of the project's needs. After being taken down to bare metal, the cab of the 1959 Ford F100 showed many small holes that were previously invisible. Patch panels over holes in the floors were also discovered.*



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# VINTAGE TRUCK RESTORATION

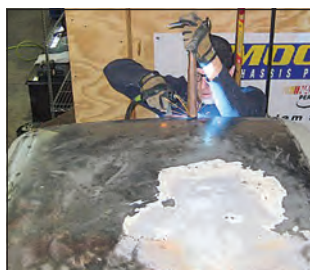
buy the exact part you'll need. And if you're looking at something like a Plymouth or Studebaker truck, finding essential bits will be hit or miss—odds are, you'll be needing a parts truck, and you'll be spending a lot of time at swap meets and scouring the pages of *Hemmings Motor News*.

For all the difficulties, though, the result is

worth the effort. Put a line of '55s together and if there's a truck among them, that's the one that stands out—you'll never see a vintage truck without a crowd of admirers at a show. A classic truck's rugged simplicity and enduring charm make it an excellent choice for a restoration where time is in greater supply than money. ●

## TOP TIPS

- Become familiar with the reproduction/used parts supply before starting.
- Make sure you have enough room. Classic trucks are big, as are their body panels.
- Some used exterior colors and other materials that don't have a car equivalent.
- Bear in mind a classic truck won't be the ideal road-trip vehicle for everyone.
- Research other restorations of similar models to discover potential pitfalls.



Even with common models, some parts just won't be available, like a roof section. A 1979 Ford donated its roof to preserve the distinctive front brow of the '59: The contours were similar. Extensive preparation of the donor was followed by fabrication of new bracing to recreate the stock appearance.



This 1954 Chevrolet pickup was originally supposed to be a quick refurbishment—a "cosmetic makeover." There was recent paint and what appeared to be a sound body, so the plan was to sand down the existing finish and respray over that. But further inspection revealed unacceptable corrosion in vital areas, and the truck came apart.



Nothing complicated here, just painted sheetmetal. As with a car, gauges, knobs and other small trim parts are always the hardest to source, and it's vital to save every piece: Remove them carefully before starting any other work, and store them in a separate, labeled container. Many people find gauge restoration rewarding.



One of the fun things about restoring trucks is how many parts simply bolt on. Not only does that make it easy to access all sides of them without cutting or subsequent welding, but in this case, removing the fenders made the rest of the cab of the '54 Chevy smaller and easier to get to, along with the running gear beneath.

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## CHAPTER 9

# FUEL SYSTEMS

### Giving your car some gas is a critical step

BY DAVID LaCHANCE

**S**een at its most basic, an automobile's fuel system is a marvelously simple thing: There's a tank to hold the gasoline, some tubing, and a way of moving the fuel, either by gravity or a pump. Yet it's fraught with the potential for failure. Every joint and gasket is a potential spot for a leak, bringing with it the very real risk of fire. And the tiniest bit of debris can bring the flow of fuel to a halt, usually at the worst possible time.

Steel fuel tanks rust from the inside out

when airborne water vapor condenses and pools at the bottom of the tank. They can rust from the outside in, too, when debris traps moisture on the top of the tank. Entire books have been written about carburetors; suffice it to say that you'll probably be dealing with the varnish left behind from evaporated fuel, worn throttle shafts and other components, as well as errors committed by former owners. It's best to take nothing for granted. ●



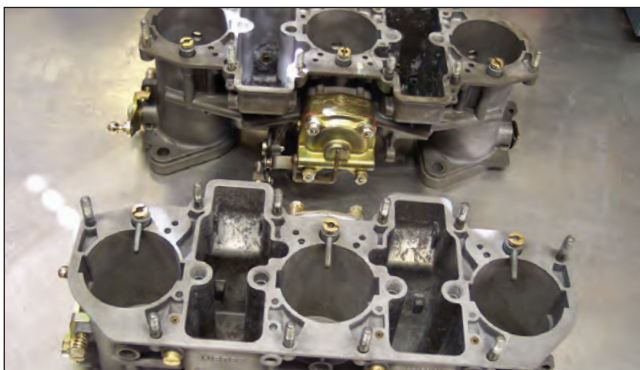
*Rusted-out and varnish-clogged gas tanks can be repaired. The process involves steam cleaning, cutting holes in the tank for sandblasting the interior, welding up the holes and coating the inside and outside with a durable rust- and gasoline-resistant material. For tanks that are intact but dirty, do-it-yourself repair kits are available.*



*When a mechanical fuel pump fails, it's usually because its diaphragm has split. Many older fuel pumps can be disassembled and repaired, though not the crimped-together pumps introduced in the 1970s; these must be replaced. It's a simple matter to test a fuel pump on the car for adequate volume and pressure.*



*Some cars were equipped at the factory with electric fuel pumps. When these stop working, it's usually because the electrical contact points have become pitted. These can be either repaired or replaced. You should hear the pump in operation when the ignition is first switched on.*



*The carburetor is undoubtedly the most frequently rebuilt component of any older car, and there's no guarantee that the last person who took it apart did the job right. If you're rebuilding the carburetor yourself, be sure to have the part number when you order a rebuild kit. Otherwise, there are many reputable shops that can do the job for you.*

### TOP TIPS

- Carry a spare, rebuilt fuel pump with you at all times, and know how to install it.
- Don't assume that your car, as found, has the proper carburetor or carburetors. It's one of those items that are often replaced.
- An electric fuel pump, hidden away on a frame rail, can provide some needed help to a mechanical pump, and solve hot restart problems related to fuel evaporation.
- Remember that a gallon of gasoline weighs a little more than 6 pounds, and that a full tank will put some strain on its mountings. Make sure they're sound.
- Even if your car didn't have one originally, fit a good quality fuel filter, and change it regularly.

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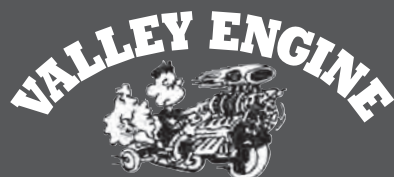
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## CHAPTER 10

# SUSPENSION

Without maintenance, a smooth ride will only last so long

BY MATTHEW LITWIN

**C**ollectible vehicles of all types—whether a classic, a muscle car or a European sports car—are supported by a suspension system, which serves two distinct purposes: passenger comfort and control. Whether your vehicle has an OE-type (original equipment) or aftermarket system (designed to provide modern handling characteristics), when it's functioning as designed, it's easy to forget that it's there. But that doesn't mean that the suspension should be neglected; rather, it's an integral part of your car, and a properly restored and maintained suspension will add plenty of pleasure to your driving experience.

On a system that's in constant motion, such as a suspension, wear can occur slowly over time,

assuming the system is properly lubricated on an annual or semi-annual basis. Failure to do so will quickly degrade passenger comfort. More detrimental results from a failure to maintain your suspension could be considerable: wheel hop on aged road surfaces, under braking or cornering, as well as excessive body roll while cornering; this last factor can also result in tremendous under- or oversteer.

While considering an older vehicle, whether as an enjoyable driver or as a project, think about the underpinnings. Here, we point out some of the suspension components worthy of constant monitoring during your restoration, and when your car is once again on the road. ●



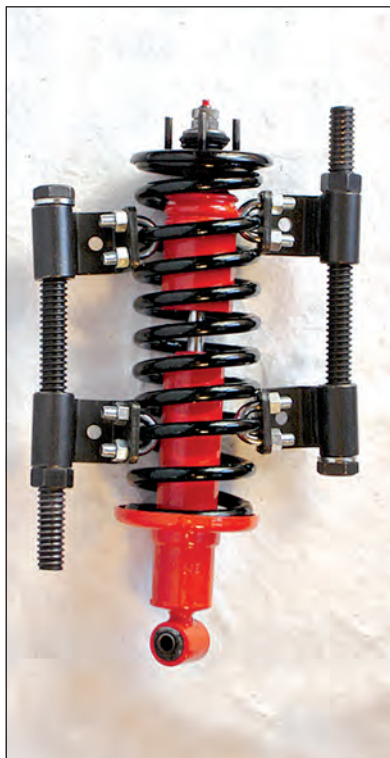
*Although front upper and lower control arm designs differ from one manufacturer to another, most are equipped with bushings where they are bolted to the frame/subframe. Providing free movement and protection against shock, the bushings are prone to wear over time, based on your driving habits. Replacement bushings are widely available, but actually swapping them will require some time and patience—their tight fit will necessitate a specialized press or careful use of a workbench vise.*



*During the early years of the domestic automobile industry, the front suspension was based on a kingpin system. Kingpins have traditionally been proven to manage a heavier load under vertical travel. Unlike a ball joint system, which can be replaced very easily, replacing a kingpin system is more difficult; it may require the honing of the mounting holes. Although circular, they adjust the camber and wheel alignment through elliptic means; it might be best to consult with an expert before tackling a kingpin system.*

### TOP TIPS

- Never leave a part with an elongated bushing hole in place; reusing a damaged control arm could lead to excess wear or even failure.
- Keep an eye on the cushioning ability of your shocks, and replace as needed to ensure a comfortable ride; reproductions are often readily available.



Depending upon the design of the front and/or rear suspension, some of the easiest components to install are the shock absorbers, regardless of whether they are hydraulic or gas-filled. Generally speaking, four small nuts and bolts hold tubular shocks in place; vintage knee action (lever) shocks will require more time to swap. While OE-style tubular shocks are generally discarded, knee action shocks can be rebuilt. For coil springs, it's best to acquire a spring compressor, which will ease installation.



There are two common types of rear suspension: coil-sprung, and the leaf-sprung system depicted here. Both systems function similarly and have their own advantages and faults. Both systems also utilize bushings at select mounting points; these can be replaced in the same manner as the front bushings. Parts unique to leaf spring systems such as shackles and leaf assemblies are relatively simple to obtain; the easiest method to install them is as a subassembly to the chassis.

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# COOLING SYSTEMS

There's more to good health than a can of radiator flush

BY DAVID LaCHANCE

**T**he passage of time is not kind to idle cooling systems. Silt solidifies in engine blocks and radiators, hoses deteriorate, seals harden and leak, and corrosion inhibitors lose their potency, allowing components to become badly damaged on the inside while still appearing unaffected on the outside.

For these reasons and more, it's important not to take shortcuts around your car's cool-

ing system as your restoration project moves forward. Fortunately, this segment of the hobby is very well served, which means that virtually all parts are available either as reproduction or refurbished units.

It's no fun to have to keep a constant eye on the temperature gauge of your freshly restored car. Do the job right at the start, and you'll be rewarded with many trouble-free miles of enjoyment. ●



*Sediment can harden in radiator cores, greatly decreasing their cooling efficiency. Radiator specialists can usually "boil out" the cores and repair leaks, or install entirely new cores, using your original tanks. Reproduction radiators are available for many cars, too.*



*Don't assume a water pump is in good shape just because it looks fine on the outside. Impellers can corrode, or become loose on their shafts, making the pump ineffectual. Seals harden and leak, too, and bearings can fail. For peace of mind, consider having your pump rebuilt, or buying a reproduction.*



*Carefully inspect your cooling fan for cracks and deformities, and make sure the blades are firmly attached to the hub. If yours has a thermostatic clutch, as most do, it should spin freely when the engine is cold, but offer resistance when the engine has been warmed to operating temperature. If it fails this test, replace it.*



*It's a good idea to replace every bit of rubber hose that carries coolant, and to make sure there are no blockages in any metal pipes. Hoses can deteriorate and collapse on the inside; replacing them is relatively cheap insurance against failure.*

## TOP TIPS

- If you're adding air conditioning to your classic car, be sure to find out if a radiator upgrade is required.
- You can save yourself a lot of trouble by servicing the water pump while the engine, or at least the radiator, is already out of the vehicle.
- An add-on electric fan can help an older car deal with the strains of stop-and-go traffic.
- If your temperature gauge reads high but the engine shows no signs of overheating, your gauge itself might be at fault. Borrow or buy an infrared thermometer to find out what's really going on.



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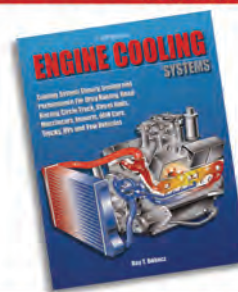
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## CHAPTER 12

# STEERING SYSTEMS

### Going straight is only half the goal

BY MATTHEW LITWIN

**I**t would be hard to point out one piece of a vehicle as its “most critical” system, but if you’re traveling at highway speeds, there’s one thing that just might be more important than stopping: steering.

Control of a collectible vehicle is integrated into its suspension system, and must endure the same aggravated input from changing road conditions and the driver. Because it’s so important

to actually driving and enjoying your vehicle, it’s imperative that the steering system passes careful scrutiny. Several steering components are subject to wear; fortunately, in nearly every case, finding OE-style replacement parts is a relatively easy task. Specialty companies and general parts stores alike should be able to provide the required parts, while aftermarket companies can provide updated components for a more modern feel behind the wheel. ●

#### TOP TIPS

- Not all Pitman arms are the same: Adding power steering will require installing a compatible unit.
- Fine adjustment of the threaded tie rod sleeves controls the front wheel alignment. Be sure the alignment is within tolerance for your vehicle.



*The front spindle is the last critical part of the steering system in which the wheel/hub assemblies attach. Should a wheel bearing fail at this location, it will quickly wear a groove into the spindle (as shown), compromising its strength, which could eventually cause a catastrophic failure. Stress cracks from fatigue could also hint at a future problem. Spending a few extra dollars for a new spindle and new wheel bearings now will lead to a lifetime of driving enjoyment, rather than a damaged vehicle.*



*Inner and outer tie-rod ends—linked by a threaded sleeve—are some of the critical components that provide a vital link between driver input and the spindles. This means that the outer tie rods are also subjected to more movement because of the manner in which they react to suspension travel; proper lubrication is critical in preventing excess wear. Most owners will not restore the tie-rod ends, choosing instead to buy new replacements. Installation is a snap: One end is threaded into the aforementioned sleeve, while the other is slid onto the spindle and held in place by a nut.*



Fluid loss due to a faulty steering box seal or brittle power steering hose can mean loss of response or control. Replacement power steering hoses are easy to install. Power steering boxes can be rebuilt by specialists and are not difficult to change, but the task can be cumbersome if the engine and other steering components are in place. The box is bolted to the frame or front subassembly with three or four bolts; in many cases, the steering shaft will have to be disconnected, as will the Pitman arm. Many aftermarket steering boxes (as shown) have been designed to fit stock mounting points.



A single Pitman arm is all that's required to transfer steering input from the associated box to the center link. Usually stout in design and weight, the Pitman arm is fairly durable, though a heavy impact—whether from another vehicle or from driving at excessive speed over rough terrain—could damage it. Removing a damaged Pitman arm may require some effort because of the manner in which it is bolted to the steering box. Proper alignment of a new arm is critical—failing to do so will result in directional pull once the steering gear self-centers.

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## CHAPTER 13

# BRAKE SYSTEMS

A hard pedal doesn't mean all is well; here's what to consider

BY TERRY McGEAN

**W**hether you're completely restoring a vehicle or just refurbishing an old car to get it back on the road, you're going to want to give the proper attention to the braking system for obvious reasons. Hydraulic brake systems deteriorate over time, particularly if the vehicle has been sitting—all those soft seals that keep the fluid from leaking will dry out if they're not used, and the presence of moisture can also lead to corrosion of the system's steel and iron parts.

For safety's sake, the brake system of any old-car project should be gone through from stem to stern before returning to the road, even if only to inspect the various components. The master

cylinder and the drum-brake wheel cylinders all have seals that can deteriorate and lead to failure, even if the part looks sound; brake-line flex hoses can also maintain proper outward appearances while becoming compromised. Of course, rust can plague OE mild-steel hard lines and ruin friction surfaces of brake drums and rotors. In general, long-term dormancy—even when your car is stored indoors—can be hard on brake systems.

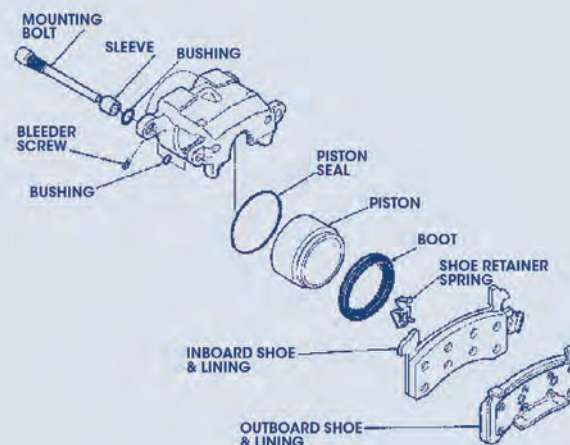
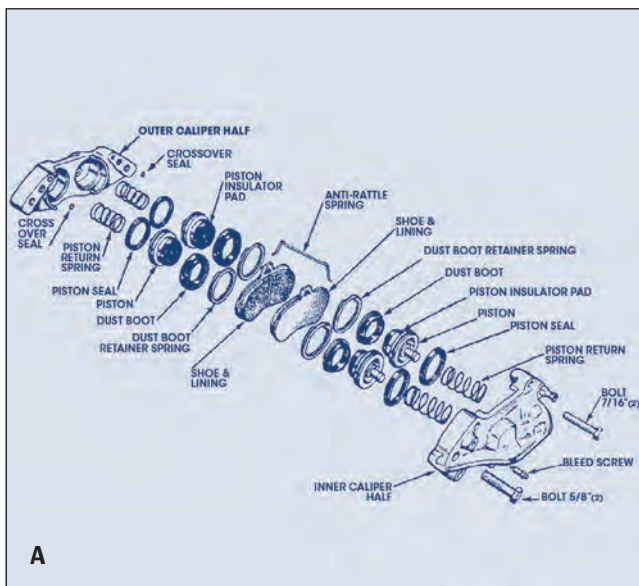
The following photos highlight some of the areas of the braking system to consider when approaching an old car project; while you don't necessarily have to replace every piece of your old system, attention to detail here is worth the effort. ●



*Conventional glycol-based brake fluid attracts moisture, which is the main reason that this fluid should be flushed periodically even on cars in regular use; for old cars that have been sitting for years, the old fluid really should be eliminated completely. Old fluid is also a problem because the moisture can cause internal corrosion of the machined bores in the master cylinder, wheel cylinders and disc calipers.*



*Drum-brake assemblies should be inspected for excessive wear, leaking hydraulics (which will contaminate and ruin friction materials), broken springs and rust. Shoe pivot points and linkages must be lubricated with light grease, along with the contact points on the backing plate. Remember to check the wheel or axle bearings for excessive wear, as this can put the drum out of alignment and cause uneven braking; leaking axle seals will also contaminate friction materials.*



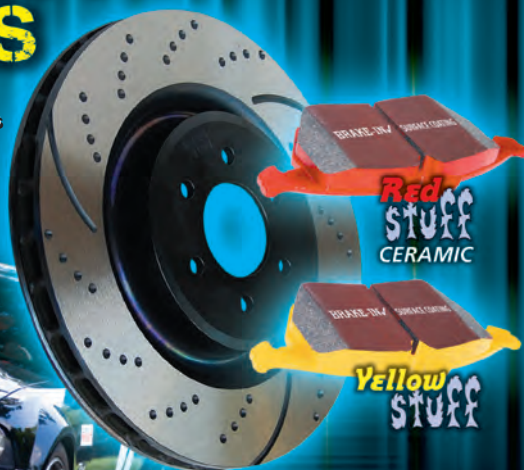
Disc brake calipers can suffer from corrosive pitting to the pistons and bores, which will interfere with proper operation and lead to leaking hydraulics. The moving parts of sliding-

type calipers should be cleaned and lubed (A); fixed calipers can be "split" to remove seals and pistons for replacement (B). Rebuild kits are usually available, and often simple to install.

Continued on page 95

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# ENGINE RESTORATION

## Laying the groundwork for the rebuilding process

BY TERRY McGEAN

If you're restoring a car, there is almost certainly an engine rebuilding project in your future.

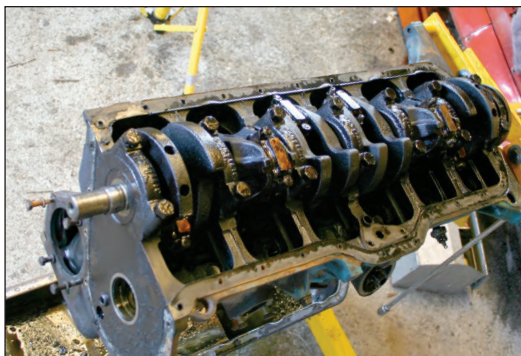
What exactly this will entail will depend on the type of engine, what parts are available for it and your skill level, but there are a number of steps in the process that are common to most engine builds. Some restorers will simply remove the engine to be used and drop it off at a machine shop, while others will perform as much of the work as possible themselves. Having some basic knowledge of this subject will enable you to do at least some of the work on your own, potentially reducing your labor expenses a bit; it will also help you to better communicate with the machine

shop that you'll be working with.

There isn't space here to cover the myriad details involved in engine building, but we will attempt to provide an overview of the general steps to serve as a primer for the uninitiated. Patience and attention to detail, even during the disassembly process, will prove to be worth the effort in the end; this process should not be rushed. If, after reading this, you feel inspired to dive in, do some additional research first—a manual on your specific engine will be invaluable, and a good book on general engine building and machining will also be beneficial. Read over the following steps and go from there. ●

### TOP TIPS

- Verify the condition of your core before investing in rebuilding it.
- Consult with the machine shop before you bring parts or commit to the job.
- Have a manual with factory specifications and procedures on hand—don't guess.
- During assembly, keep everything clean, proceed slowly, and check the work as you go.



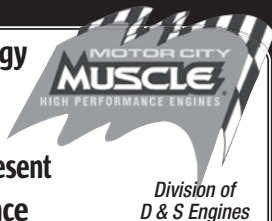
*Before any engine building can even begin, you have to secure your core. It may seem elementary, but too often, assumptions are made about the engine being pulled from a project. Before you order any parts, you must tear down and inspect the subject engine to determine if it's a viable candidate for refurbishment in the first place.*



*After the core engine is removed from the vehicle, or has been otherwise procured, remove the intake manifold and the cylinder head(s). Questions that need to be answered include: Are there any critical cracks in the block? Can it be over-bored? Is the crankshaft salvageable? Will the block have to be align-honed? Consulting with a machine shop will help to shed light here.*

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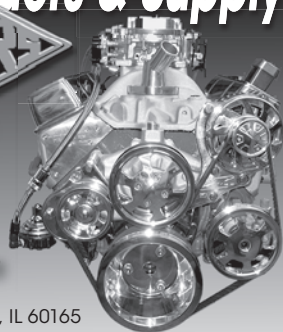
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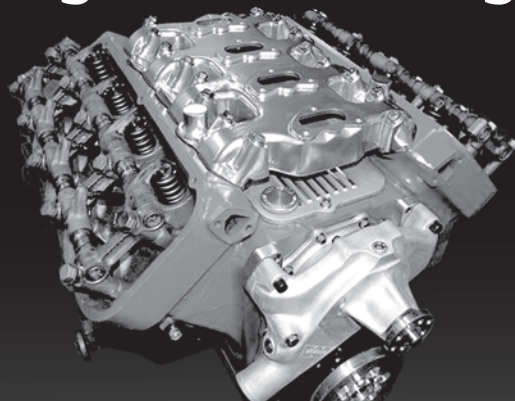
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# ENGINE RESTORATION



Once your core has a clean bill of health, you can proceed by completely disassembling the engine. All fasteners should be saved, even if you intend to replace them, and everything should be “bagged and tagged” for future reference. Return connecting rod caps to their rods and replace the fasteners; the main caps should also be returned to their respective positions on the block.



Although machine shops are equipped to clean engine parts, you’ll be charged for the time, and the shop may appreciate it if you don’t bring them a greasy, filthy mess. Some time spent with a putty knife, wire brush and plenty of degreaser will at least make the parts easier to handle, and less likely to spread filth. Power washing works well, too, if you have access.



By the time you drop off your parts, you should already have discussed the project with the shop, and you should have inventoried all of your items—photos are good insurance, too, both to jog your memory later and to provide proof of what you’ve delivered, should anything get lost. Crankshafts should be handled carefully, even if machining is planned, as journals can easily be damaged in transit beyond the scope of undersizing.



Once at the shop, the machinists will again measure the critical dimensions of the engine block, primarily the bore diameters. Just about any engine that uses a cast block without some sort of cylinder liner will have to be over-bored to restore the proper dimensions of the bores, which tend to wear unevenly. Oversize pistons are usually only a problem with unusual engines (though the aftermarket has come a long way here), but there may be an issue if the engine has been over-bored previously, or if the bores rusted while sitting.



Once it has been determined that the block can be over-bored, the boring process will begin with a specific final dimension as a goal—usually .030-inch over standard. Thin-wall or rare blocks may be taken only .020-inch, while those with bigger issues may go .060-inch over, or even more if the casting can accommodate it. Machining progress will be checked periodically, but the final dimension will actually be achieved via final honing.



By the time the block is ready for final honing, the pistons should be on hand, as the machinist will want to measure them to ensure that the bore is sized accordingly. Some machinists use a torque plate, which bolts to the engine block’s deck using the cylinder-head mounting points and simulates the stresses imposed on the block by the head bolts, which can alter the bore dimensions. This is usually done only in race engine shops, and torque plates are often only available for popular high-performance engines—it is not required.

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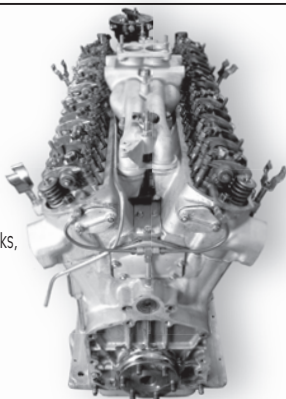
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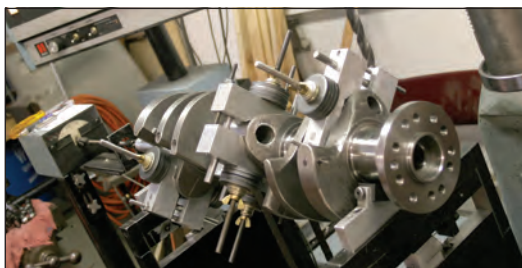
# ENGINE RESTORATION



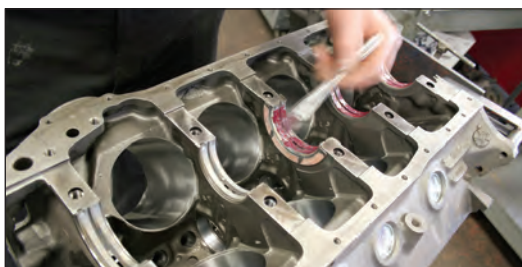
Some basic engine-building processes involve simply fitting new pistons to the original connecting rods, but many shops recommend replacing the rod cap fasteners, and most agree that this mandates resizing the rods. This process involves machining the flat mating surfaces between the cap and the rod, and then honing the big end of the rod to return it to the proper dimension.



If the engine being used was in good shape, it's quite possible the crankshaft can be reused without much more than a cleanup, and possibly some time spent polishing the journals. Unfortunately, it's more common to find the crank's journals worn and possibly scored to the point that they will require machine work. This entails precision grinding to undersize the journals, usually .010-inch the first time. Corresponding oversize bearings are then used to maintain factory-specified clearance dimensions.



The rotating assembly must maintain balance to minimize vibration; manufacturers used mass-production techniques for this, which often did not yield perfectly balanced engines. Additionally, when components are altered or exchanged, proper balance can be lost. For basic rebuilds, custom balancing is considered optional, but it's often worthwhile. The balance rig uses bob weights filled with shot to replicate the weight of the piston/rod assemblies; balance adjustments are usually made by drilling the crankshaft's counterweights.



With the block machined, the crankshaft and connecting rods reconditioned, and the new pistons mounted to the connecting rods, reassembly can begin. By now, the block should have been thoroughly washed—a warm mixture of soap and water is often used—to remove any lingering debris from the machining process; any metal filings left behind can wreak havoc with the new parts. The main bearing shells are set into the block saddles and coated with assembly lube of some sort just prior to setting the crankshaft in place.



Install the piston rings on the new pistons by hand—some people use no tools for this, while others like to use a ring expander. A gentle touch should be used to expand the rings just enough to fit over the piston dome. The rod bolts should be covered in preparation for installation in the block, to keep them from scratching the crank journal on the way in—options include rubber hose lengths, old spark-plug boots or the special covers seen here.



After lubing the cylinder walls with oil and applying a light coat of oil to the rings and ring grooves, the piston-and-rod assemblies can be installed into the block. A ring compressor of some sort should be used to smoothly guide the rings into the bores. Most of these are adjustable and are tightened over the rings on the piston, but for popular bore sizes, there are fixed-size tapered ring compressors, as shown.



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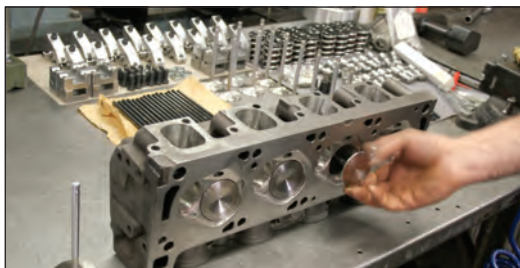
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# ENGINE RESTORATION



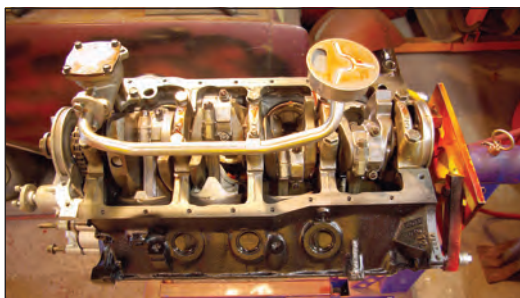
*If the original cylinder heads are to be reused, they should first be disassembled and inspected. A valvespring compressor will be required to compress the valves far enough to remove the keepers and retainers; these tools can be purchased reasonably from some auto parts stores, or Sears. Before using the compressor, take a socket that matches the diameter of the spring retainers and strike each one with a hammer to loosen any deposits. Before any further work is done to the heads, the castings should be checked by the machine shop for cracks.*



*Once the castings have been cleaned and testing has shown them to be sound, the valve job can proceed. Valve seats will likely show wear, which can be corrected by grinding or cutting the valve seats with specialized equipment; some engines will require hardened valve-seat inserts to be installed to better cope with unleaded fuel. Valves can be resurfaced or simply replaced. Valve guides, if worn, can be drilled and fitted with new inserts or, in some cases, treated to knurling to reduce clearances.*



*With the cylinder head(s) rebuilt and reassembled with new valve seals, inspect the new head gaskets to ensure that they are correct for the application by lining up the various bolt holes and coolant passages; some gaskets are also marked to show which side faces up. If dowels were used to locate the heads, make sure they're in place—head bolts are not intended to position the head. Check a factory manual for the proper torque specification, as well as the sequence, and make two or three passes around the bolts before arriving at final torque. Check to see if the gaskets you're using require re-torquing after start-up.*



*After installing the cylinder head(s), the long-block is nearly complete. It's a good idea to rotate the engine several times to make sure everything feels right—there will be significant drag, mostly from the new rings, but it should not bind, and there shouldn't be any free play in the rotating assembly. Check the oil-pump pickup's relationship to the pan to ensure that it is close to the pan's floor, but not touching— $\frac{1}{4}$ -inch of clearance is all most engines require. After sealing the pan and installing the intake manifold and other bits, consider pre-lubing the engine with a drill motor prior to initial firing.*

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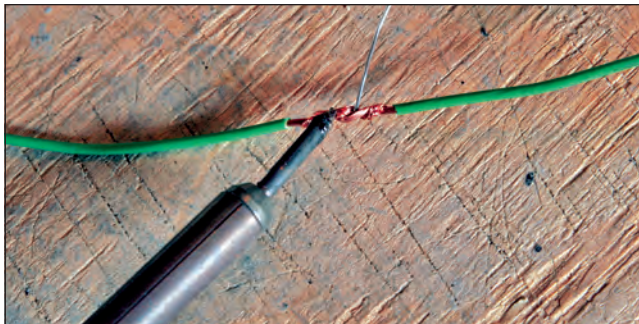
Don't get zapped by faulty wiring or connections

BY DANIEL STROHL

**A**side from perhaps the fuel system, there is no more immediately critical system in your collector car than the electrical system. After all, without ignition, you won't be going far, and without lights and a horn, your local constabulary will take a dim view of your presence on the streets.

Yet the electrical system is also perhaps the most poorly understood. Most people have

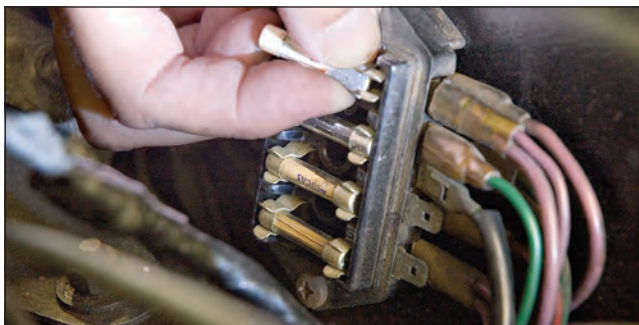
a difficult time comprehending the flow of electricity, the difference between volts and amps, and how to trace a circuit. Repairing and maintaining your collector car's electrical system doesn't require a master's degree in electrical engineering, but you should probably have at least a rudimentary understanding of what's going on in your wiring harness before you delve too far into it. ●



*Before undertaking any wiring repair yourself, learn how to properly solder wiring connections and stock up on heat shrink to shield your wiring repairs from corrosion. It's also a good idea to purchase a test light or multimeter and to learn how to use them to troubleshoot electrical faults.*



*When troubleshooting your car's electrical system, keep in mind that every circuit must come to ground somewhere. Corrosion and loose connections often cause bad grounds, and forgetting to check grounds can lead you on a wild goose chase.*



*Over the years, we've seen some ingenious get-home replacements for fuses that were left to become permanent. However MacGyver-smart they might be, they're still incredibly unsafe: Correct fuses will prevent circuits from shorting out and potentially causing a fire.*



*Headlamps, taillamps and turn signals are a necessity for getting your collector car registered pretty much anywhere you might live, so make sure these are in working order. Besides allowing you to see the road at night, they allow other motorists to see you, so it's a good idea to upgrade them all to the brightest bulbs possible.*

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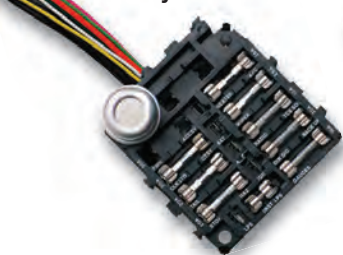


Factory Fit® manufactures the older "bolt in head" designs, 60's spring ring style, and 70's side terminal molded design.

American Autowire offers a free online OEM wiring quote tool at <http://shop.americanautowire.com>. Find all the restoration parts and prices available to your specific year/make/model vehicle! Factory Fit® catalogs can also be downloaded for each GM model at <http://www.americanautowire.com>.

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While modern sealed batteries require less maintenance than older batteries, it's still important to keep your battery fully charged, especially during the off-season. Fortunately, there are plenty of battery tenders available today that will keep your battery charged while your car rests in storage. Make sure to periodically inspect your battery cables as well—aged and corroded battery cables may look fine on the outside, but still not carry a current.



Whether your car runs an alternator or generator, make sure that it's working as it should to charge the battery. If your car does not use a commonly available alternator or generator, you can easily find a rebuilding service that will make your car's alternator or generator as good as new.

### TOP TIPS

- Be diligent about checking for corrosion to prevent bad grounds and faulty connections.
- A multimeter is an inexpensive, indispensable addition to your tool arsenal.
- Choose the brightest bulbs available for your car's lamps.
- Correct fuses are an easy way to keep your car running right.

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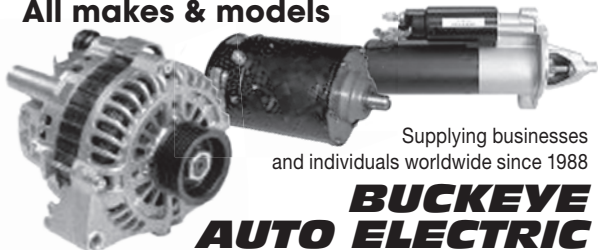
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# TRANSMISSION REBUILD

## Gearbox repair: A DIY job or a task best left to the professionals?

BY MIKE McNESSOR

**T**ransmission rebuilding and repair is one aspect of auto restoration that frightens many enthusiasts. Rebuilding a conventional manual gearbox is an excellent project for the advanced restorer—it's probably not for the beginner.

While there's really no black magic involved in rebuilding a three- or four-speed manual transmission, it does require an understanding of how the gearbox operates, the ability to follow instructions and, in many cases, a few specialty tools. We once asked a master transmission rebuilder if, when he rebuilt his first transmission, he just jumped in and did it himself. He told us that he started out with the simplest gearbox he could find and then worked his way up to the more complicated units.

At minimum you'll need a shop manual devoted to the disassembly and repair of your transmission. If you're lucky enough to be working on

one of the more common transmissions, you can even find how-to videos, available either on DVD or posted online.

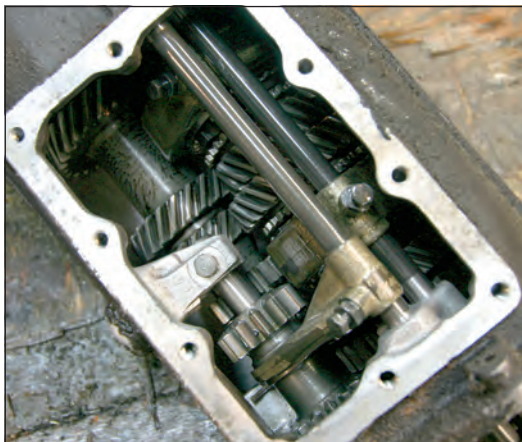
Most of a manual transmission can be disassembled and reassembled using common tools, although for many transmissions, you will need access to a hydraulic press, as well as a dummy shaft to help drive out the countershaft and countershaft gear. Gear pullers, too, might be necessary, depending on the type of transmission you are rebuilding.

In this pictorial, we follow along with John Esposito, proprietor of Quantum Mechanics in Monroe, Connecticut, as he works his way through a fairly typical four-speed transmission with the ease of a person who's been doing this sort of work for years.

For leads on transmission parts or rebuilders in your area, check out the Services Offered section of *Hemmings Motor News* under "transmissions." ●



*If you're looking to save some money, clean your transmission up before bringing it in for repair; otherwise, you'll most likely be charged for the work. Moreover, the shop will probably appreciate it if you don't dirty up their workspace, and it'll make the transmission less annoying to handle, to boot. Some degreaser, a hose washer and a stiff brush will work wonders on even the grimeiest transmission. If you have access to a parts washer, that'll work well, too.*



*With the fluid drained and the side cover off, there is no major damage evident, but this is a superficial indication of the transmission's health at best. Synchros can be worn, shift forks might be tweaked or worn out and bearings could be loose or worn. The only way to find out is to dive in.*

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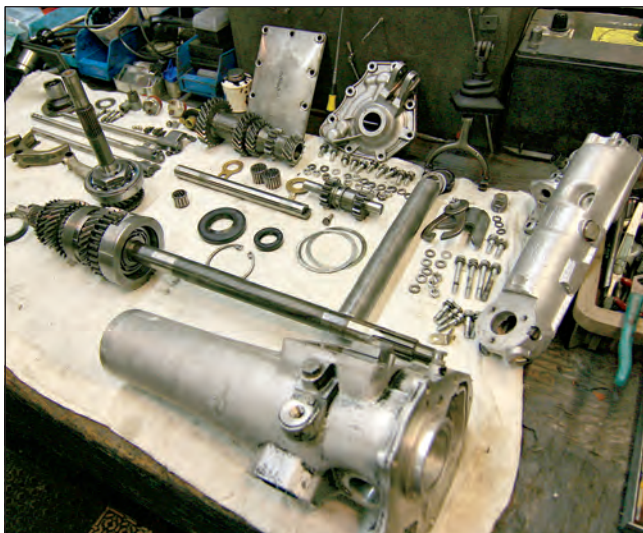
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## TRANSMISSION REBUILD



*Once you're this far, there's no turning back. With everything cleaned and arranged on the bench for reassembly, we can also assess what needs to be replaced. It should go without saying, but don't reuse high-wear components. Bearings, races, seals, O-rings, synchros, snap rings and gaskets are throwaway items that will be included in most transmission rebuild kits (where applicable). While everything is apart is a good time to inspect the cases and shafts for burrs or damage that might cause seals to fail down the the road.*



*Like a carburetor rebuild kit, some transmission rebuild kits cover a range of units, which might have similarly shaped cases. In this instance, the kit included a gasket for a four-speed transmission as well as a gasket for an overdrive transmission from the same family. It should be obvious which to use by matching the part with the casting, but be sure not to mix parts up.*



*This transmission was in good condition, but there were still metal filings hiding in nooks and crannies, even after a couple of hours slaving over a cold parts washer. The easiest way to make sure metal bits don't wind up mixing with your new parts is to sweep the inside of the transmission clean with a magnet.*



*John reinstalls the mainshaft, its gears and the bearing carrier with a hammer and a practiced hand. This should frighten you a little if you've never tackled such a job, and it's one of many reasons why you might want to farm this work out to a professional.*



With a little additional cleaning and some fresh paint, the transmission will soon be ready to go back in the car. Total time from start to finish for our transmission specialist was four hours. At shop rates, you could be looking at \$400 to \$500 in labor, plus \$150 to \$350 for the rebuild kit. So is this a DIY job? Maybe, if you are truly interested in the challenge or have some experience. Otherwise, it might make more sense to remove your transmission, clean it and drop it off at the shop.

### TOP TIPS

- Consult with your rebuilder before you bring parts or commit to the job.
- Have a manual with factory specifications and rebuild procedures on hand while working.
- Spring for a new clutch and throwout bearing, and have the pressure plate checked while the gearbox is out.
- During assembly, keep everything clean, proceed slowly and check the work as you go.

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# BODY REPAIR

Practice, patience and some professional help makes perfect

BY MIKE McNESSOR

**C**onsidering tackling some aspect of your vehicle's body reconstruction yourself—or even doing it all? It's a good way to save money and take an active role in the preservation of your historic ride.

Depending on your skill level, your confidence and your expectations for the finished product, your participation can range from doing the entire job, start to finish, or digging into one part. Most entry-level restorers are comfortable doing their own disassembly work and paint stripping. Taking your vehicle apart in preparation for stripping requires organization, planning and patience, but no special training beyond a willingness to learn and get dirty.

Paint stripping is probably best tackled with a DA sander or chemical stripper. Both methods are

time-consuming and messy, but approachable with a minimal investment.

With the body stripped, you'll be able to see what metal work is actually required. You can then assess whether or not to proceed, or call in a professional. Those interested in applying newly learned welding skills might consider attacking a floorpan or a trunkpan (see accompanying photos). Though strength is important in these areas, cosmetics here might be less crucial than in more visible locations. Likewise, performing finish body and paint work on the floors or in the trunk is a good way to learn how to apply body filler and paint.

Whatever level of involvement you're comfortable with, it never hurts to seek advice from a professional or a knowledgeable hobbyist before getting started. ●



*Here are just a few of the tools a DIY auto body restorer is going to want in his or her arsenal: an air chisel (left) with an assortment of specialty panel bits, a dual action sander (center) and a few rolls of self-adhesive pads of various grades for stripping paint, a panel cutter (top) for making cuts in sheetmetal and an air grinder (right) for quickly cutting through paint and rust.*



*Looking for a place to hone some newly acquired metal working skills? The floorpan, like the one on this 1961 Chevrolet Impala, is a good place to start. While the majority of the floor was quite solid, the metal in the lowest parts of the pan was thin and perforated due to moisture collecting there. The chalk mark around the inside was made using the new replacement pan as a guide.*

## TOP TIPS

- A few specialized tools will make tackling metal work on your own much easier. Consider investing in the right equipment now, so you're set when you're ready to take on larger repairs.
- Talk to professionals or knowledgeable hobbyists before proceeding. Start with stuff you are comfortable with: stripping paint, patching floorpans, etc. You can do more as you hone your skills.

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## BODY REPAIR



*With the gas tank removed, a panel cutter or cutoff saw proves ideal for cutting away the old sheetmetal because it's easy to control, and eats through small sections at a time. It's also one of the most inexpensive metal working tools available and useful for not only sheetmetal repair, but also exhaust systems and more.*



*Next, you'll want to grind the edge of the metal in the area of the lap joint between the original trunk and the new pan. This will make it easier to weld while also pointing out any thin spots. Butt joints look prettier, but lap joints are stronger. As long as the weld is solid on both sides and sealed, rust won't be a problem.*



*In the rush to see the finished product in all its done-it-myself glory, it's easy to forget the basics. Use a level to make sure that the new pan isn't pitched at some weird angle. It doesn't have to be correct to the thousandth of a millimeter, but it's going to look funny if the floor is tilted, so take the time to get things squared away now.*



*With the pan sitting in place, it's tempting to grab the MIG gun and zap a few tack welds in the corners to hold it in place. However, it's better to drill a few holes and use sheetmetal screws to hold the pan—unlike welds, screws can be easily removed if last-minute adjustments are necessary. Once the pan is finished, simply back the screws out and weld up the holes.*



*Once satisfied with the new pan's fit, begin the process of making it a permanent part of the car. Work your way around the pan, applying small tack welds so you don't overheat the metal and warp the panel. Keep working your way around until all the dots of weld are connected, forming a continuous bead. Then do the same thing to the back side of the joint. Grind everything smooth, reweld as needed, then smooth with body filler.*

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## Restore or replace? It depends on the part and its condition

BY RICHARD A. LENTINELLO

**R**estoring the trim on an old car or truck is one of those specialized tasks that very few home hobbyists can do themselves. It takes an incredible amount of metalworking skill and experience to reshape trim that has been badly bent or heavily dented back to its proper form without making the metal rip.

If the trim pieces that surround the windows and run down the side of the body are made of aluminum or stainless steel and they are dented in a few places, you can, with a lot of patience, work the dents out using special metalworking hammers until the metal surface is smooth again; then you just polish the metal to the correct finish. Trim that is made of aluminum or stainless steel is not plated, so it's fairly easy to restore that metal's original appearance, getting it just the way it looked when it was first installed on the car.

However, if the trim is plated in chrome or nickel, you'll have no other choice but to send it to a professional chrome-plating specialist to be restored. This is a highly specialized job, requiring numerous tanks of various chemicals that, when combined, create chrome plating. This is also one of the more expensive jobs of the restoration, so set aside the needed funds in advance.

If you plan on having your car completely restored by a professional restoration shop, you'll need to take lots of general photos of the car beforehand—but you should also take numerous detailed photos of all the trim pieces to document their condition prior to sending the car to the shop. Note the condition of each trim piece, even

if it's in fine shape, but particularly if it's broken or missing components; let the shop know ahead of time if there are any broken or damaged trim pieces to avoid any disputes about it later on.

Rather than having the exterior trim pieces restored and/or replated, you can purchase new trim parts instead. This may save you money overall and provide you with new parts that look perfect—but only if trim pieces are available for the car or truck you are restoring. Lots of trim has been reproduced, but these items are mainly for the most popular cars, due to the strong demand to restore them. These include cars like Camaros, Chevelles, Corvettes, Mustangs, Falcons, Corvairs, Firebirds, GTOs, Tri-Five Chevys, Thunderbirds, VW Beetles, MGs and Triumphs, as well as most 1950s and 1960s-era American pickup trucks.

When it comes to restoring the exterior, besides the brightwork, also consider the glass, such as the side and vent windows, front windshield and rear backlite. For the cars mentioned above, new glass has been reproduced and is readily available at affordable prices, but glass for older models may prove more challenging to obtain. Still, for older cars and trucks, especially those of the pre-war era, there are glass shops that still possess the original patterns from which they can cut new glass for you; this is limited to flat glass.

When installing new glass, always use new weatherstripping and window channeling. This will not only enhance the car's finished appearance, but it will also hold the new glass in place more firmly and help eliminate water leaks.

### TOP TIPS

- Document every piece of trim on your car and detail its condition before sending anything out to a shop for work. This will help avoid disputes over broken or missing pieces later, and will help you reassemble the car correctly when it's time to put things back together.
- Some models have readily available reproduction glass; for more difficult-to-supply vehicles, check with a glass shop to see if new pieces can be made from original patterns. Glass can also sometimes be restored.
- Don't neglect your weatherstripping. Putting in new, correct weatherstripping will hold your glass in place securely and add a finished touch to your restoration.
- While you can often purchase new reproduction taillamp lenses, you can also restore your original lenses using any of a number of convenient compounds currently on the market.
- Old bumpers can be straightened and replated, or you can purchase new bumpers from the aftermarket.

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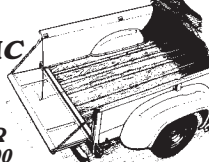
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## BODY TRIM

New taillamp lenses, emblems and scripts can be bought from aftermarket restoration suppliers, or you can choose to have the originals restored. This is well worth the time, effort and expense in order to give the restored vehicle the final touch of a quality restoration. Again, the availability of reproduction lenses and emblems depends on the car that you are restoring and its popularity.

And let's not forget one of the most important exterior trim pieces of all: the bumpers. If the bumpers on your car or truck are bent, twisted

or dented, in most cases they can be repaired to as-new condition by a good chrome-plating shop. Very particular owners would much rather pay to have their old bumpers replated, rather than buying reproduction bumpers, in order to retain as many original parts as possible. Of course, for those cars previously mentioned, as well as several others, new reproduction bumpers are available, which may be cheaper to buy than having your old bumpers rechromed. Like everything else, there is no right or wrong way: the choice is yours. ●



*Installing the windshield and rubber channel must be done after the exterior body has been painted; in order to prevent scratches to the new paint, protect the surrounding area with a double layer of autobody paper before installation begins.*



*With all the panels and parts restored, painted and bolted in place, use autobody paper wherever you have to install body trim. Even when you have to pull the wiring harness through the correct openings, always protect the surrounding areas.*



*When installing emblems, moldings, marker lamps, grilles or bumpers, make sure all the fasteners are new; coat their threads with anti-seize paste and use the right tools. If the bumper is already installed, protect it with paper or tape.*



*Installation of the interior door panels, C-pillar covering and rear package shelf needs to be done before the carpeting and rear seats are installed. This will prevent damage to the new seats, and will give you more room to move around.*

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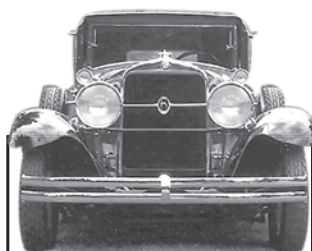
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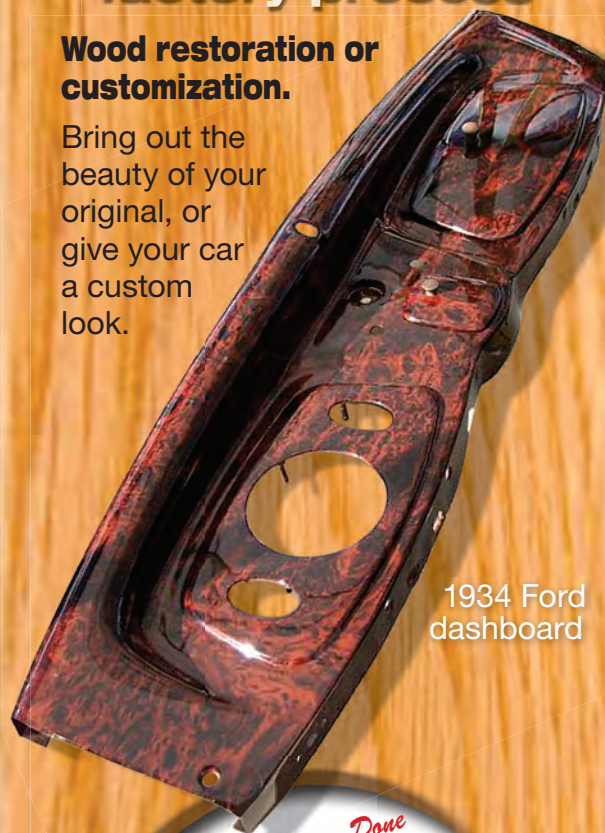
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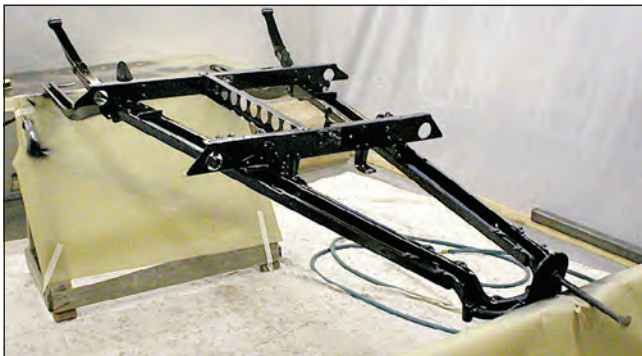
BY RICHARD A. LENTINELLO

**O**ne of the most difficult jobs of the entire restoration process is the refinishing of the exterior. Painting is a labor-intensive process that requires lots of hands-on experience to do the job correctly, not to mention several specialized tools, such as an air compressor, spray gun and protective mask. Because of the high cost of today's primers, paints and chemicals and the amount of labor involved, it is also the single most expensive job that you will have to contract out if you want a high-quality finish.

If you want to paint your car yourself, never fear: It can be done. All that's needed is the desire and determination to do it...and a whole lot of patience to do it right. Of course, you'll need a decent spray gun, air supply and a place to do the actual spraying, but don't think for a moment that by having professional-quality equipment

you will automatically achieve professional-quality results. You'll need to practice in order to get the ideal spray pattern and to develop your hand technique to lay down the paint just right. There's a reason why restoration shops charge what they do, but with a little practice you'll be amazed at what you can achieve at home, even in a one-car garage using an entry-level spray gun.

Preparation is everything: Without a properly prepped body, not only won't the paint not stick well, but the final finish will not be smooth. The most important step in the painting process is the cleaning stage, as even the smallest speck of grease will prevent the primer from adhering properly. We recommend using a specially formulated degreaser and pre-sanding solvent cleaner meant for removing grease, wax and silicone prior to painting; all the major paint



*Whether you are painting a bare chassis, suspension parts or an entire body, you must work in a clean room that is free of dust. When taping off the bottom of the car, use autobody paper instead of newsprint, which is greasy and can adversely affect the new paint.*



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## PAINTING

manufacturers offer these helpful products for cleaning and prepping your car.

If you are going to be painting in a garage with exposed, dust-covered rafters and shelving packed with dirty car parts, buy a roll of thick plastic sheeting and drape it across the ceiling and walls to prevent any dust particles from falling onto the wet paint. Sweep and vacuum the floor the day before you paint, but whatever you do, don't wet the floor before you start painting because when the water evaporates, it will become trapped under the paint, which will cause your new paint to lift.

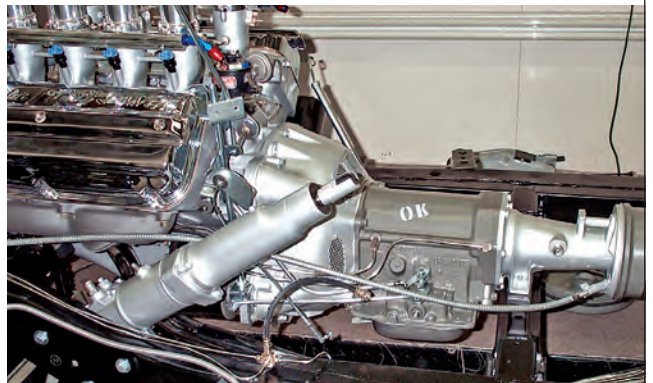
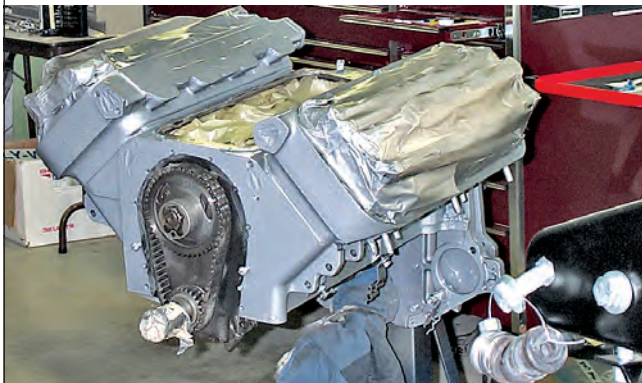
One of the biggest decisions to be made is the type of paint to be used. You'll have to choose from acrylic enamel, single-stage urethane enamel or basecoat/clearcoat urethane enamel, which is the most durable. The urethane paints require a catalyst that allows the paint to dry and harden, but this is extremely hazardous to your health; you should never spray urethane paint without the use of a mask that has a fresh-air supply.

Urethane is also very expensive compared to the much more affordable acrylic enamel. And

keep in mind that colors affect the cost of the paint, as well. Reds, oranges and yellows cost far more than blues, blacks, grays and most greens, and metallic paint is more expensive still.

Besides deciding which paint to use, you'll also need to choose your type of primer. With so many different primers on the market, it can be very confusing to select which type of primer to use—not only when, but where. Beyond all the different brands, there are numerous different types, each designed for a specific purpose. There are primers made of lacquer, acrylic and urethane, plus primer sealers and primer surfacers. Most primers are also available in a variety of colors, too, so they can better complement the color topcoats, thus allowing you to either intensify or subdue the hue of the final color depending on which light or dark primer is used below.

For the ultimate in protection and adhesion, we're firm believers that the first primer coat should be an epoxy primer. Epoxy may be more expensive, but when you are already spending thousands of dollars restoring the car of your dreams,



*Using a rotisserie to rotate a bare chassis or entire body will make painting those parts easier by giving you better access, plus the final finish will be far superior. Transmissions and engine blocks can be refinished with urethane autobody paint with great results.*

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## PAINTING

a few extra bucks isn't going to break the bank.

Epoxy has several distinct advantages over standard primers. Its main benefit is that epoxy is nonporous when cured, so it is not permeable, which means that it won't soak up moisture like conventional primers and primer sealers. Because it's waterproof, its excellent corrosion-resistant properties make it the only logical base primer to use, especially if you reside in a damp climate.

Another advantage is epoxy's optimal adhesion abilities. Its chemical makeup provides excellent adhesion to the bare metal surface below, making it the ideal basecoat for all the necessary primers, sealers and topcoats to follow, as well as any body filler.

When it comes to the actual spraying of the color coats, more is better: When in doubt, spray on an extra coat of paint, or three. You're going to wet-sand it anyway, so a little extra paint is good insurance. And that's the key to a quality finish: thorough wet sanding to remove every trace of orange peel or roughness, then buff, buff and buff

some more, until the paint looks like glass.

If you don't want to try painting your car yourself but still desire a show-quality finish, there are other options—even if you can't afford the high cost associated with such professional quality work. Talk with your local autobody shop about having them do just the final spraying. You will remove all exterior trim, and take care of any welding or bodywork beforehand, while they do the spraying of the paint. In fact, you can even prime the car yourself and just pay them to apply the final color coats. Then you'll need to decide if you want the shop to do any color sanding or final polishing that may be necessary.

Another worthwhile option is to rent a spray booth from a nearby autobody shop. Most autobody shops are closed during the weekend, and are sometimes willing to rent out the use of their spray booth for a nominal fee, which is usually only a few hundred dollars.

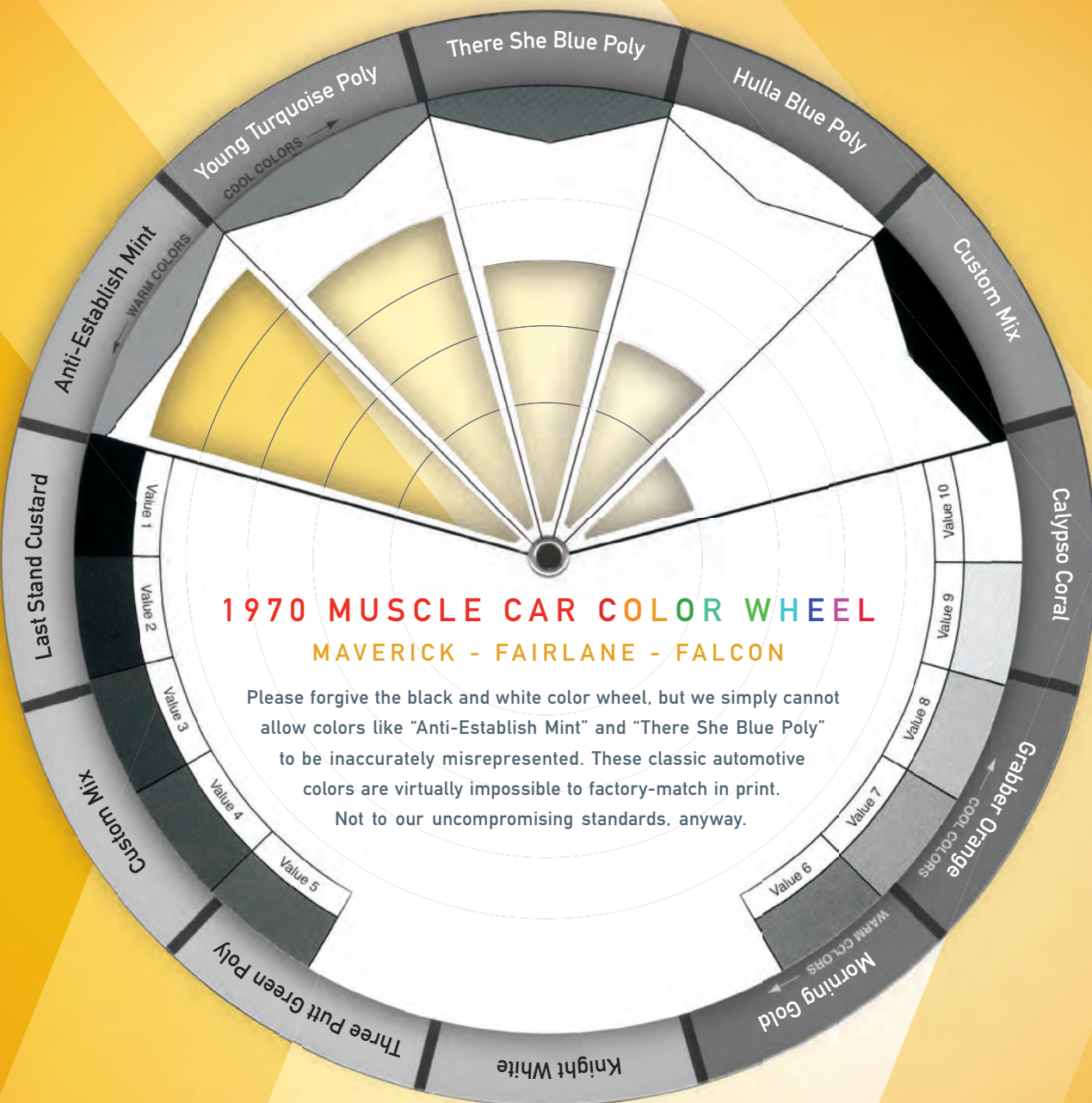
Sometimes, a little resourcefulness goes a long way. ●



*It's easier to spray bodies in sections than try to paint the entire structure all at once. Before spraying the exterior, paint the dashboard and interior. Then use autobody paper to protect those newly painted areas when the time comes to refinish the exterior.*

### TOP TIPS

- **Cleanliness is critical:** Make sure that your paint area and car are both spotless before beginning to apply your finish.
- **Carefully consider what type of finish you want to use based on your requirements for the final restoration:** Acrylic enamel, single-stage urethane enamel and basecoat/clearcoat urethane enamel all have their own advantages and disadvantages.
- **Final sanding and buffing shouldn't be neglected.** The elbow grease you put in will be rewarded with a glass-like finish at the end.
- **If you don't have a paint booth of your own and can't cordon off your garage, consider renting a paint booth from a local shop or sending the car out for only the final paint application.**



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# CONVERTIBLE TOPS

What goes down must come back up again

BY DANIEL STROHL

One of the greatest joys of classic-car ownership is putting down the top on a convertible before taking a scenic drive as the sun's rays shower down on you. One of the greatest disappointments of classic-car ownership is getting caught in a rainstorm, raising the top, and finding out that the rips in that top will leave you having a shower of another sort.

Convertible tops, while called on to perform the same duties as a regular steel top—blocking wind, rain and all the other undesirable elements—are more susceptible to those elements and

abuse than hard tops, and thus are often found in poor condition on older vehicles. Of course, that won't prevent you from enjoying the car when the weather's nice, but unless you live in Happy La-La Land, where everything's perfect all the time, you'll eventually want to raise the top.

While it's possible to repair some portions of a convertible top, in most cases you'll want to go through with a full replacement. Contrary to popular belief, with the right tools and preparation, replacing a top is something the home restorer can do on his own. ●

## TOP TIPS

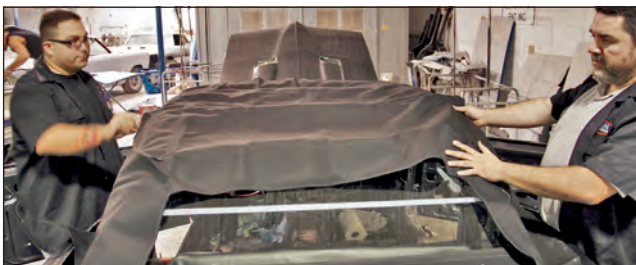
- While replacement kits are often available, an upholstery shop can also make a replica.
- Store your car with its new top up to avoid damage.
- Always check power components for proper function.



Replacement convertible tops are available on the after-market for most popular models of convertibles and should include all the ancillary items that go with a top, including the pads, the rear window and the hardware. The bows for your convertible top will likely be in good condition—check that they're straight, and make sure the cork-like material in the bows is solid enough to staple into. If no aftermarket top is available for your car, an upholstery shop will be able to replicate your old top by taking careful measurements.



When planning to replace a convertible top, schedule the task for after the car has been painted (so as to keep overspray from settling on the new top) and before the carpet and seats have been reinstalled in the car (to avoid damaging or dirtying new carpet and upholstery material). After installation, a convertible top should be left up for at least a week to stretch out packaging creases. When in storage, make sure to leave the top in the "up" position to both keep it stretched and to discourage rodents from nesting in the folds of a retracted convertible top.



The exact methods of anchoring the top may differ from car to car, but tops are generally secured to a rail at the base of the rear window and then stretched forward, securing at the header panel. Power convertible tops, whether hydraulically or electrically operated, will have hydraulic cylinders or electrical motors that should be inspected and, if necessary, replaced or rebuilt.

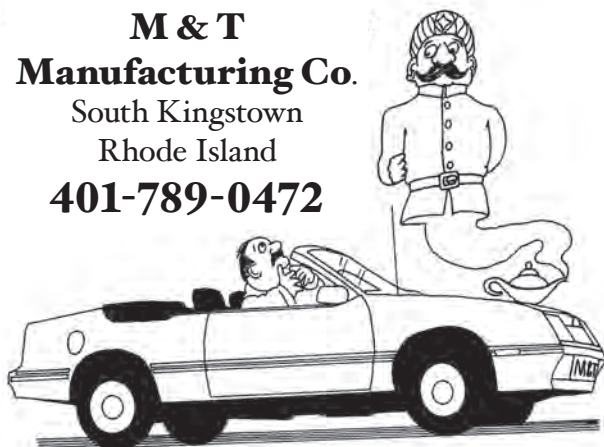
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## CHAPTER 21

# UPHOLSTERY

### What makes a collector car most comfortable is inside

BY DANIEL STROHL

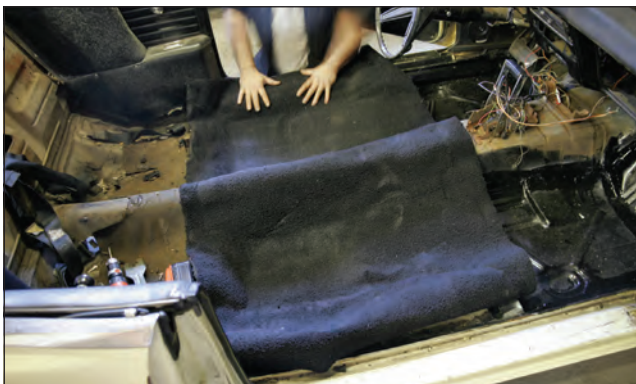
A car's paint and body shape may dictate whether you're attracted to it, while its mechanical condition may determine how much time you spend wrenching on it. However, how much time you spend behind the wheel actually driving it will depend largely on how comfortable and pleasing the interior and upholstery are. After all, you won't drive it long with springs poking through the seats or with a headliner sagging down around your noggin.

Fortunately, there are many things a home re-

storers can do to improve the look and feel of his collector car's interior beyond a mere vacuuming at the coin-op. Contrary to popular opinion, refurbishing your car's interior does not demand arcane knowledge, nor does it require more than a handful of specialty tools. Carpet, seat upholstery, headliners, door panels and more can easily be replaced, and with the help of the aftermarket, many popular models of collector cars can be freshened without the aid of a sewing machine. It's all a matter of knowing where to look, and being willing to try something new. ●

#### TOP TIPS

- Noise and heat barriers are good additions to your floor and headliner.
- An upholstery shop can use your original seat covers to make new patterns.
- Test the stuffing on your seats to make sure they're comfortable.
- Protect your car's interior by keeping it away from damaging sun and heat.
- These tips, and many more, come from CarTech's *Muscle Car Interior Restoration Guide*, available at bookstores or at [www.carttechbooks.com](http://www.carttechbooks.com).



*Though the jute padding that the factories placed underneath carpeting usually gets the blame for trapping moisture and causing floorboards to rust, it's actually the carpet itself—which doesn't permit moisture to evaporate—that ultimately causes the rust. Before putting down new carpet, consider lining the floor with a noise and heat barrier to make for a more solid and silent ride.*



*Headliners come in two different styles: bow-type, which uses a series of several parallel bows to hold up the headliner material (shown here); and shell-type, which uses a fabric-covered molded fiberglass or fiberboard shell in the shape of the underside of the roof. The underside of the roof can benefit from a noise and heat barrier lining just as much as the floorboards.*

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New seat covers can either be purchased through the after-market or made by an upholstery shop, using your old seat covers for patterns. When reupholstering seats or when lifting your car's carpet, look for the car's build sheet, which will help with documenting your collector car. A set of hog-ring pliers will be your most valuable tool during this process.



When replacing your seat covers, be sure to replace any broken springs in the seats and install new or additional foam padding between the springs and seat covers. Installing the seat covers themselves is simply a matter of sliding the covers over the frames and padding, then stretching them to fit. Make sure not to over- or under-stuff the seats with padding.



Some interior items, such as padded and vinyl-wrapped dashboards, are better sent off to companies that specialize in the restorations of those items. All interior vinyl surfaces—and dashboards in particular—are susceptible to weakening and cracking when subjected to intense heat and UV rays, so make sure to keep your car's interior cool and out of the sun whenever possible.

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## CHAPTER 22

# FINISH WORK

Patience and caution are the keys to final assembly, and a job well done

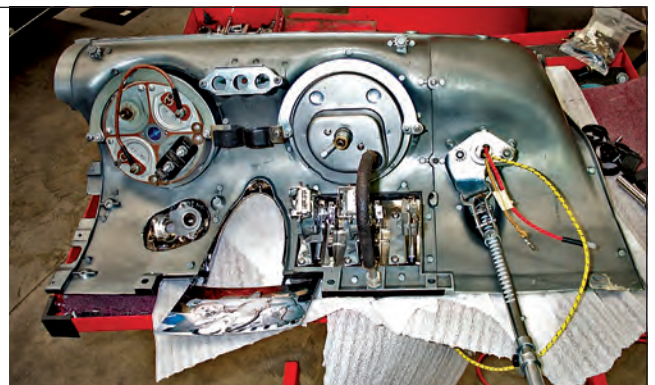
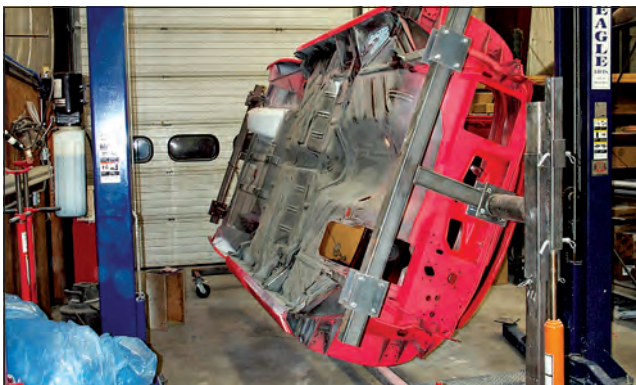
BY RICHARD A. LENTINELLO

**B**elieve it or not, the most time-consuming part of a restoration is the final finish work. This is what can make or break a restoration. Numerous very tedious tasks, most of which are fairly time-consuming, are involved, making this a part of the project that you might be inclined to cut corners on—the end is in sight, and you just want to drive your freshly restored car, after all. But when you rush the work, screwdrivers slip and scratches are made—and that's how you wind up back at square one. Talk about the final stages of assembly being the most frustrating part of the entire project.

Yet the finishing stage can—and should—be the most rewarding aspect of the whole project. This is the time when all the little details come together, and what was once a disassembled mass starts looking like a complete car once more. But

when it comes to finishing work, there's more than just bolting on bumpers or screwing on door panels.

Let's go back a bit into the meat of the project. If your goal is to perform a concours-quality restoration, in which every square inch of the car has been finished to perfection, then you will need to have unimpeded access to the entire vehicle. Whether you are working on a car or truck that has a unibody or one that has a body that can be unbolted from the frame, you should consider using a rotisserie. This tool will allow you to rotate the body 360 degrees, letting you work on the undercarriage, floorpan and underside of the rocker panels while you're standing, or even while sitting. The unobstructed access that this tool provides is unbelievable, affording you the opportunity to execute as perfect a restoration as you dare to



*Having the proper tools, workbench and room to spread out makes putting the car back together a lot easier. A rotisserie comes in handy to install brake and fuel lines on a unibody car, while heavy-duty jackstands will ensure your safety when working underneath the car.*



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## FINISH WORK

do. And even when the welding and painting are completed, the rotisserie will come in handy when you start to install fuel and brake lines, suspension components and numerous fasteners.

If your garage has the space, consider buying a lift, either four-post or two. Besides the ease of working on the underside of the vehicle that such a lift provides, even after the restoration is completed, you will find yourself using it for maintenance duties for years to come—not to mention as above-storage for another car, since a second vehicle can be parked below. With the vehicle on a lift, you will be better able to connect the transmission linkages, driveshaft, emergency brake cables, exhaust systems and many other pertinent mechanical components quickly and accurately, with a lot less chance of scratching or chipping your newly applied paintwork.

After your vehicle has been painted, if you need to lift it using a jack, you can prevent chipping of the new paint by covering the jack's contact surface with clean rags and some thick foam to cushion the impact during the lift. Use nonabrasive

blankets to protect the fenders and radiator support area from being scratched while work in the engine bay continues, and don't forget to protect the newly upholstered seats and carpeting with thick plastic sheeting fitted over blankets.

When installing any type of trim or decorative brightwork atop or adjoining the newly restored and painted exterior, you first need to protect that surrounding finish by covering the surface with thick, non-oily autobody paper topped with cardboard. Smaller areas need to be covered with a few layers of the type of soft-stick tape that will not remove the new paint when peeled away; it's either the blue or green kind, often labeled as "painter's masking tape."

Certain types of trim, such as rain gutters and the trim that's fitted around the wheel wells, sometimes needs to be tapped into place; in order to prevent the trim from being dented during the installation process, you'll need to use a soft-faced wooden mallet with a layer of soft pine fitted in between the trim and mallet.

When fitting emblems, badges, scripts and



*Keep your work area well lit, clean and free from obstacles to prevent you from tripping and hurting yourself and the vehicle. Use tape to protect chrome trim from being scratched when using the buffer, and put towels on all lifts and jackstands to protect the chassis.*



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## FINISH WORK

hood ornaments, the affected area will need to be covered with soft-stick tape—use two layers or so to ensure that the surrounding paint won't get ruined should the tool you're using slip.

If you need to tighten down a part onto a freshly painted surface, and especially if you need to install something that requires direct contact of a nut and washer with the painted area, you should think ahead: A little dab of grease under the washer sometimes helps prevent the washer from tearing the paint away. The nut itself needs to be tightened very slowly to avoid forcing the washer into the paint, thereby chipping it. But please be aware that no matter how hard you try to avoid such a problem, you'll probably end up cracking the paint: Most nuts and bolts have to be tightened to a particular torque setting, and in many cases, the force of the required torque will make the paint crack. This is inevitable. Paint chips and cracks such as

these will have to be touched up with a fine artist's brush later on.

When dealing with door panels that are held in place with numerous screws, protect the surrounding area with lots of tape, or a thin piece of cardboard with a small hole just big enough for the screw head to be accessed. Install the screws slowly to avoid slipping with the screwdriver; there's no point in rushing the job at this stage.

Bumpers are big and clumsy, and can be very heavy: Avoid damaging not only the bumpers, but also the body to which they are to be attached by having two friends give a helping hand. With one helper holding the bumper at each end, slowly fit the bumper to the body while you fasten it in place. But before doing so, apply two or three layers of soft-stick tape to the surrounding holes where the bolts that hold the bumper to the body are fitted, to keep the paint from being scratched or chipped. ●



*Don't use any type of tape except clean-release painter's tape to protect any painted areas from scratches when you're installing trim or when you need to paint wheels two different colors. It will not damage the paint below when it's pulled off.*

### TOP TIPS

- Go slowly when reassembling your car. Rushing now will cause you to make costly mistakes or to damage the work you've already done.
- Stock up on soft-stick tape, which is intended to come away cleanly. Use it to mask sensitive areas while you're installing trim or tightening bolts.
- You'll probably crack the paint when tightening bolts. Use an artist's paintbrush and a steady hand to touch up these inevitable bits of damage.
- Protect the new interior of your car during final reassembly by covering carpets and upholstery with soft blankets, then covering those with thick plastic sheeting.

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# GETTING STARTED

*Continued from page 10*

## STARTING A RESTORATION

One of the questions that we hear most often regarding restoration projects is, "Where do I begin?" Many first-time home restorers just don't know which jobs need to be done first, and there's no better way to learn than to ask.

When undertaking such a monumental project, certain tasks are high priority; they need to be treated as such because they have a direct effect on many other jobs that immediately follow. Just like building a model kit, a certain order of construction needs to be followed for the model to be built correctly and efficiently.

If you are going to do a complete restoration, one where every nut, bolt, bracket and wire is removed, choosing the order in which certain jobs are to be done will have a huge effect on how long it will take to complete the project. More importantly, you want to avoid losing interest in the project due to being overwhelmed by the sight of 16,000 parts scattered all over your garage floor. But if you plan ahead and do everything in carefully choreographed stages, you'll keep your interest level high and the project will have a greater chance of being finished. The chapters of this guide will give you a basic idea of where to begin, and what order to start in.

## BODY-OFF RESTORATIONS

In this restoration, the body of the car is removed from the chassis.

If you plan on performing a body-off restoration, first remove the engine and transmission and set them aside. Don't take them apart just yet; right now, you need to concentrate on getting the body in order. If your car has a separate frame, do not remove the body from the frame until you've completed all the bodywork. Restoring the body is the hardest and most labor-intensive part of a restoration, so do that first, while your gung-ho enthusiasm is still flying high.

If the floorpan, rocker panels or quarter panels have to be replaced, you need to do this work while the body is still attached to the frame, otherwise the body will distort, twist and sag if removed from the frame, resulting in poorly aligned body panels with irregular gaps between them. And to ensure that the body is resting in its natural position, make sure the bodywork is performed while the car is sitting on its tires—you'll need to keep the suspension on.

Once the bodywork is completed and the entire body shell has been painted, you can then take the body off and start restoring the frame and all its components. Now's the time to send the engine out for whatever machine work it may need, and order the interior. ●





# HOW TO CHOOSE A SHOP

*Continued from page 31*

bi-weekly or monthly basis. Each invoice statement should include detailed labor descriptions, a listing of all purchased parts and a brief outline of the progress made. Finding a restorer who is understanding and flexible is almost as important as finding one who is qualified. Set a budget with the shop owner prior to the start of the project. The restorer will then work against advanced installments until all the money is used up.

One often-overlooked item is insurance. It is wise, especially if your car is rare and highly valuable, to carry full insurance coverage while it's being restored at the shop and while being transported. It is also important for you to take photographs of the entire restoration. This documentation will

be extremely valuable when you need to substantiate your claimed ground-up restoration, should you decide to sell the vehicle at a later date or to make an insurance claim.

Since restoration is a labor-intensive craft, most cars and trucks will take more than a year to restore. When your vehicle is complete, the restorer should give it an extensive road test to see if everything performs as it should, and then it should be handed over to you. There should be no problems at all. The car must be satisfying to drive and provide the same level of responsiveness that it did when it was new. Only then will you know if the restoration was a success. Remember, a fine restoration is substantially more than just cosmetics. ●

## TOP TIPS

- Spend time in a few restoration shops to get an idea of how they work.
- Conduct thorough interviews with shop owners and get references.
- Choose a specialist in your particular car's make.
- Be prepared for cost overages based on extra work.
- Always keep your car insured while it's under restoration.

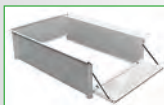
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# BRAKE SYSTEMS

*Continued from page 51*



*Flexible couplings can deteriorate internally, causing external leaks or even internal restrictions; if the parts are old and have been out of service for a long time, consider replacing them. For obsolete applications, custom lines can often be made by specialists, including high-performance lines with braided sheathing that resist expansion for firmer pedal feel.*



*Brake system hardlines are commonly made from mild steel, which is susceptible to corrosion; failure soon follows. The aftermarket can provide replica lines, bent to match the originals, and offers the option of stainless steel to stave off oxidation; some of these companies will even take your old lines and copy them if they lack your application in their catalog.*



*Master cylinders of old cars that have been sitting a long time should be rebuilt or replaced; rust in the bores can create an issue for the home rebuilder, but specialists can often sleeve corroded castings if the part is obsolete.*



*If your car uses a single-circuit braking system and you intended to drive it often, consider converting to dual circuits. Again, the aftermarket can help.*

## TOP TIPS

- Consider your aftermarket options, which include durable stainless steel lines or braided sheathing.
- Keep the friction points on your drum brakes lubricated for the best performance.
- Always flush brake fluid regularly, and change it completely if the car's been sitting.
- A dual-circuit upgrade could considerably enhance your car's stopping power.



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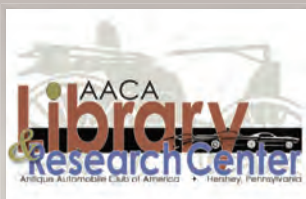
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